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for the
District of Columbia Circuit

TRANSCRIPT OF RECORD

BRIEF OF APPELLANT

In the United States Court of Appeals For the District of Columbia

No. 9135

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United States Court of Appeals
for the District of Columbia
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EDWIN L. WIEGAND COMPANY,
Appellant,

v.

CASPER W. OOMS,
Commissioner of Patents,
Appellee.

APPEAL FROM THE DISTRICT COURT OF THE UNITED STATES
FOR THE DISTRICT OF COLUMBIA.

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JURISDICTIONAL STATEMENT

This appeal is from an adverse judgment of the District Court of the United States for the District of Columbia, in a suit under R. S. 4915, U. S. C., Title 35, Section 63.

The District Court had jurisdiction under the circumstances that the Commissioner of Patents, by decision of the Board of Appeals, had refused certain claims in two applications for letters patent of the United States assigned to and owned by plaintiff, and that the said suit was brought without appeal having been taken to the Court of Customs and Patent Appeals, and within six months from the date of said decision. (Complaint, Jt. App. 2-9.)

This Court has jurisdiction under the provisions of the Judicial Code, Section 128, U. S. C., Title 28, Section

225, under the circumstance that notice of appeal from said judgment was filed within three months from the date of said judgment. (Judgment, and Notice of Appeal, Jt. App. 14.)

STATEMENT OF THE CASE

This matter arises from two applications for letters patent of the United States, by Edwin L. Wiegand, pertaining to electric heating elements, and assigned to plaintiff-appellant, Edwin L. Wiegand Company.

In the first or parent application, serial number 361,997, division was required, between claims to the article and claims to the process of manufacture, and applicant elected to go forward on the article, but retained the process claims, to permit subsequent appeal on the requirement for division.

However, to avoid delay on the process, applicant filed the second application, serial number 390,371, repeating the disclosure of the parent application, and claiming the process, and therefore a division of the parent application, if the requirement for division were finally sustained.

In due course the two applications proceeded to final actions by the Examiner. In the parent application 361,997, the Examiner allowed some claims to the article, but rejected the further article claims, and also adhered to and rejected the retained process claims on the requirement for division. In the divisional application 390,371, the Examiner allowed some claims to the process, but rejected the further claims, also to the process.

(Complaint, particularly paragraphs 4 and 5, Jt. App. 2-3, admitted in the first paragraph of the Answer, Jt. App. 10, and the two applications as amended, Exh. 1 and 2, Jt. App. 43-70 and 71-94a.)

From these actions of the Examiner applicant filed appeals to the Board of Appeals, and in due course the Board of Appeals entered its decisions. In the parent application 361,997, the Board allowed some additional claims to the article, but rejected the remaining article claims, and also affirmed the rejection of the retained process claims on the requirement for division. In the divisional application 390,371, directed entirely to the process, the Board allowed one additional claim, but rejected the remaining claims. (Decisions, Exhs. K and N, Jt. App. 123-127 and 133-135.)

From these decisions of the Board of Appeals plaintiff filed suit under R. S. 4915, in the District Court of the United States for the District of Columbia, and from the adverse judgment of the District Court plaintiff has brought this appeal. (Complaint, Jt. App. 2-9; Judgment, Jt. App. 14; Notice of Appeal, Jt. App. 14.)

During the course of the proceedings in the District Court it appeared that four of the claims in suit of the parent application 361,997, need not necessarily be interpreted as intended, and therefore plaintiff withdrew those claims, that is, claims 14, 33, 35, and 44, of the parent application 361,997. (Findings of Fact, paragraph 2, Jt. App. 11.) During the course of this appeal plaintiff has become satisfied to accede to the requirement for division between article and process, and now withdraws the remaining process claims 15 through 22, of the parent application 361,997.

Thereupon, by agreement of counsel, the withdrawn claims have been omitted from the printing of the Complaint in the Appendix, and therefore the claims appearing in the printing of the Complaint in the Appendix, are directly the claims involved in this appeal, that is, of the parent application 361,997, claims 34, 36 through 41, and 45, directed to the article, and of the divisional application 390,371, claims 2 through 5, 10, 12, and 20, directed to the process.

Further, any of those claims are rejected only as not patentable over the patents to Vogel 2,094,480 and Backer

2,157,884. (Findings of Fact, particularly paragraphs 6 and 10-13, Jt. App. 12-13.) Wherefore apparently the only question on this appeal, is whether the above claims are properly refused by reason of the above patents to Vogel 2,094,480 and Backer 2,157,884.

The developments of the applications in suit relate to what are known as tubular electric heating elements. Tubular electric heating elements have been on the market in any event since 1922, and for some years previously. However, those elements were round in cross-section, as shown for example in the preliminary Figures 1 and 2 of application 361,997. (Jt. App. 15-16, 26, and for the drawings of application 361,997, Jt. App. 69-70.)

Referring to these preliminary figures 1 and 2 of application 361,997, the prior tubular heating elements included a long tubular metal sheath, such as the sheath 30, the actual length of which was of the order indicated by Figure 10, and which was round in cross-section, as shown in Figure 2, and within the sheath was a coiled resistance wire 31, extending between terminals at the two ends of the element, indicated at 33, and embedded in granular refractory material, indicated at 32, such as powdered magnesium oxide. (Jt. App. 16.)

In operation, the terminals 33 were connected to a source of electric current, and the current passing through the resistance wire 31, is converted into heat. The refractory material 32 is required to serve the double purpose, both to insulate the resistance wire 31 electrically, and also to conduct the heat from the resistance wire 31 to the sheath 30, from which it is transmitted to the object to be heated, such as a cooking vessel resting on the element, or usually on two elements interposed one within the other. (Jt. App. 16.)

Such elements were successful, in the sense that they stayed on the market. They were sponsored by General Electric Company, and by its subsidiary, Edison General

Electric Appliance Company, and included in their ranges, and such backing naturally compelled a certain degree of acceptance. However, also they had certain disadvantages. (Jt. App. 16.)

First, they had too large a volume of refractory, which resulted in insufficient ability to conduct the heat from the resistor to the sheath. Also they had too small an area of exterior surface, which resulted in insufficient ability to dissipate the heat from the element. Combining the two, they had definitely an insufficient ratio of area of exterior surface to volume of the refractory. (Jt. App. 16-17.)

Then as applied to range units, and also to many other uses, with the object to be heated, such as a cooking vessel, resting on the element, or usually on two elements interposed one with the other, the prior tubular elements at best had merely line contact between the element or elements and the cooking vessel. Further, the prior elements likewise had insufficient rigidity, so that the elements warped, resulting in contact with the vessel at possibly only three spaced points, and a further decrease of ability to conduct the heat from the element or elements. (Jt. App. 17.)

The result of these deficiencies was that the amount of heat that could be designed into the element was definitely limited; the resistor wire became over-heated, and the element burned out. (Jt. App. 17-18.)

In this situation Mr. Wiegand produced the device Exhibit 3 (physical). Referring to the photostat Exhibit 4 (Jt. App. 95), the operation started with the tube round, as shown in the upper part of the photostat, marked R. Then after the wire and refractory had been inserted, and the ends closed, the tube was side-pressed, re-forming it to the elliptical cross-section shown in the lower part of the photostat, marked E, and present in the specimen Exhibit 3, and of considerably less cross-section than the original round tube R. Quite a number of these devices were actually made and tested, including the specimen Exhibit 3, and the operation was successful, in the sense that to some extent it did compact and reduce the volume of the refractory. (Jt. App. 18-19, 26-27.)

The above was within two or three years of 1929, and in any event prior to 1935. (Jt. App. 19, 27.) In the Backer patent (Jt. App. 106-109), the form shown in Figure 2 is referred to as elliptical, and this is correct, and in fact it is substantially identical with the form illustrated by the specimen Exhibit 3. (Jt. App. 46.) The earliest date possible to the Backer patent is January 16, 1936. (The Backer patent, Jt. App. 106-109, the filing date.) Therefore Wiegand completed and tested the form shown in Figure 2 of the Backer patent, at least one year prior.

However, at least according to the standards of the applications in suit, the elliptical form is not the solution. It still has too large a volume of refractory compared to the area of the exterior surface. Another reason, it is not sufficiently rigid in the narrow direction, and will warp. A third reason, it does not provide any flat surface. Therefore, the same as with the round elements, the cooking vessel, or other object, would be in contact only along a line, and after the element had warped, as it surely would, only at possibly three separate points. (Jt. App. 19, 27.)

On the other hand, Mr. Wiegand also had suggested making an element semi-cylindrical, that is, semi-circular in cross-section. Further, it was his idea to assemble two such semi-circular elements with their flat faces together, thus forming a round or cylindrical unit. Such elements were made and tested. Forms and molds were made, and several of the semi-cylindrical elements were made, and some of them were put together as described. (Jt. App. 20, 28.)

Obviously these are precisely the forms shown in Figures 4 and 5 of the Backer patent. (Jt. App. 106-109.)

Mr. Wiegand accomplished this by the summer of 1928. (Jt. App. 21, 28-29.) As aforesaid, the earliest date possible to the Backer patent is January 16, 1936. (The Backer patent, Jt. App. 106-109, the filing date.) Therefore Mr. Wiegand suggested the disclosure of Figures 4 and 5 of the Backer patent, at least seven years prior.

However, the assembly of the two elements, to produce the round or cylindrical form, provided no advantage. With the semi-cylindrical element, or semi-circular section, the ratio of surface area to volume of the refractory is somewhat better than with the round or cylindrical, but still not sufficient. On the other hand, the resistance to bending or warping is much lower. Therefore the slight advantage in the one respect, is more than offset by the disadvantage in the other respect. (Jt. App. 21, 29.)

Thus the fact is, Mr. Wiegand accomplished the only forms of the Backer patent that have ever been relied on anywhere in respect of any of the claims in suit, in any event prior to Backer. Also they did not provide the solution of the problem.

Consistently, on the basis of knowledge and experience in the industry, none of the forms shown in the Backer patent have ever been made and sold commercially. (Jt. App. 24, 36.)

With reference to the Vogel patent (Jt. App. 101-105), Mr. Wiegand had proposed side-pressing the element, to produce a flat on one or both sides, as now shown in the Vogel patent, and thereupon the Wiegand Company actually made and tested elements as now shown and described in the Vogel patent. (Jt. App. 19-20, 28.)

This also was definitely prior to 1935. (Jt. App. 20, 28.) Yet the earliest date possible to the Vogal patent is May 16, 1936. (The Vogel patent, Jt. App. 101-105, the filing date.) Therefore likewise Wiegand completed and tested elements as shown and described in the Vogel patent, at least one year prior.

Those elements were satisfactory, in the sense that they were better than an element having an elliptical shape, in that they did provide a flat contact surface. However, they also had much too large a volume of refractory compared to the area of the exterior surface. Also, if they were flattened enough for the flat to be of any value, they would be even less rigid in the narrow direction, and would warp even more. (Jt. App. 20, 28.)

In this there was no net difference between the two forms, now shown in Figures 3 and 4 of the patent. The form shown in Figure 3 would accomplish somewhat more reduction of the volume, but still not enough, and on the other hand, it would be even less rigid in the vertical direction, and even more certain to warp. (Jt. App. 20, 28.)

Thus the fact is, Mr. Wiegand accomplished everything anywhere relied on against any of the claims in suit, definitely prior to either Vogel or Backer. Also nothing had yet provided the solution of the problem.

In this situation it seemed that there was no satisfactory solution, but some time later Mr. Wiegand suggested the triangle element, as shown particularly in Figure 8 of the drawings of each of the applications in suit. (Jt. App. 21, 29, and for the drawings, for example, in the parent application, Jt. App. 69-70.)

It was recognized that this would provide satisfactory flat surface for contact, and Mr. Wiegand believed it would meet the other essential requirements. Therefore dies were made, and several of the elements were made and tried, and they were extremely rigid, in every direction, and were highly satisfactory also in regard to large surface and compared to volume of the refractory. (Jt. App. 21-22, 30.)

This was in October, 1937, and the element was satisfactory. (Jt. App. 22, 30.)

However, there was difficulty in forming the element. In too large a percentage the pressing rendered the element unsuitable, in one way or another. Therefore there is another factor, it is necessary not only that the cross-section be correct in itself, but also that it be such that the elements can be made. Thus the cross-section was correct, but it remained to devise a method of making the element in that cross-section, and it was not until some time later that that difficulty was overcome. (Jt. App. 22, 30.)

At that time Mr. Wiegand suggested to re-form the element in two steps, first into the elliptical shape, which in itself had been unsatisfactory, then coil or bend the element into the desired configuration, bending it in the direction of the minor axis, and then re-form it to the triangle shape. That is, side-press the element from the round cross-section shown in Figure 2 of the drawing of the applications in suit, Exhibits 1 and 2, first to the somewhat oblong or elliptical section shown in Figure 5, then coil it in the direction of the minor axis, and then re-form it as indicated in Figures 6 and 7, into the triangle element shown in Figure 8. (Jt. App. 22-23, 30, and for the drawings, Jt. App., 69-70.)

Following the accomplishment of a satisfactory process of manufacture, the triangle element was and has continued to be highly satisfactory. It results in increase in the ratio between the exterior surface of the element and the volume of the refractory, to an entirely different order. Also in the provision of a broad contact surface, and of an increase in rigidity such that the element does not warp, and therefore in an increase of contact between the element or elements and the object to be heated, also to an entirely different order. And apparently no other cross-section will yield any results that are even comparable. (Jt. App. 23, 30-31.)

In fact, the superiority of the triangle element, over the prior round cross-section, also over any of the cross-sections of the Vogel and Backer patents, is demonstrated conclusively by the independent determinations of Doctor Johnson, professor of Mechanical Engineering, George

Washington University, set forth in the chart Exhibit 10. (Jt. App. 42-43, and for the chart, Jt. App. 100.)

Likewise a result of the superiority of the triangle element over Vogel is illustrated by the range units Exhibits 8 and 9 (physical). As distinguished from any of the forms shown in the Backer patent, in 1926 Edison Appliance started to flatten their elements, on both sides, as shown in Figure 3 of the Vogel patent. Shortly they changed to flattening only one side, as shown in Figure 4. Tuttle and Kift, after they separated from Edison Appliance, and when they started making heating elements, likewise flattened their elements on one side, as shown in Figure 4 of the Vogel patent. (Jt. App. 33-34, and for the Vogel patent, Jt. App. 101-105.)

The purpose of this flattening was to close the cracks in the refractory that were formed in bending the element into the spiral shape. There was no purpose to change the ratio between the surface area and the volume, or to change the resistance to warping. Further, the side pressing of either one or both sides effected only a slight change in the ratio of surface area to volume. On the other hand, it greatly decreased the resistance to bending and warping, more than offsetting anything that was gained in increase in ratio of area to volume. (Jt. App. 34-35.)

With the insufficient rigidity, the elements must be anchored to the support. This may be by welding the elements to the support, or by staking the support over the elements, locking the elements to the support, as shown in the Edison Appliance unit Exhibit 9 (physical). However, when an element is heated, there is longitudinal expansion, and when the elements are anchored to the support, eventually the unit becomes warped. The result is, the unit is no longer flat, the utensil does not make good contact, and the operation is very unsatisfactory. Therefore neither the prior round elements, nor the flattened elements, have ever been satisfactory, in respect either of ratio of surface area to volume, or of rigidity and resistance to wrapping. (Jt. App. 35-36.)

On the other hand, as illustrated in the range unit Exhibit 8 (physical), the triangle element is so resistant to warping, it does not require anchoring to the frame, and may be secured only at one point, merely for location, and therefore remains free to expand longitudinally, without any tendency to warp under heating. (Jt. App. 36.)

In regard to the Backer patent, the elements of the applications in suit are made by the powder process, and the Backer patent states directly, that his method could not be successfully used. (Jt. App. 24.) In fact, Backer states specifically, in an affidavit in the prosecution of the application on which his patent resulted, that there is no advantage, but rather disadvantages, in using an elliptic, square, or semi-circular shape, for the tubular type of element employing powdered insulation. (Objection to this latter evidence was sustained, but plaintiff believes incorrectly.) (Jt. App. 36-41.)

On the basis of knowledge and experience in the art, there is nothing in either the Vogel patent or the Backer patent or both, that does or would suggest a triangle element, or that a triangle element would overcome the previous difficulties. (Jt. App. 24.) The result was not to be expected. (Jt. App. 31.)

Each of the article claims in suit specifies the triangle element. (Complaint, paragraph 7, Jt. App. 3-6.)

Each of the process claims in suit specifies either the triangle element or the two stage process of manufacture. (Complaint, paragraph 8, Jt. App. 6-9.)

The applications in suit are continuations of a prior application 236,847, filed October 25, 1938. (Jt. App. 25.) Therefore there is no question of statutory bar.

STATUTES INVOLVED

R. S. 4915, U. S. C., Title 35, section 63:

Bill in equity to obtain patent. Whenever a patent on application is refused by the Board of Appeals or whenever any applicant is dissatisfied with the decision of the board of interference examiners, the applicant, unless appeal has been taken to the United States Court of Customs and Patent Appeals, and such appeal is pending or has been decided, in which case no action may be brought under this section, may have remedy by bill in equity, if filed within six months after such refusal or decision; and the court having cognizance thereof, on notice to adverse parties and other due proceedings had, may adjudge that such applicant is entitled, according to law, to receive a patent for his invention, as specified in his claim or for any part thereof, as the facts in the case may appear. And such adjudication, if it be in favor of the right of the applicant, shall authorize the commissioner to issue such patent on the applicant filing in the Patent Office a copy of the adjudication and otherwise complying with the requirements of law. In all cases where there is no opposing party a copy of the bill shall be served on the commissioner; and all the expenses of the proceedings shall be paid by the applicant, whether the final decision is in his favor or not. In all suits brought hereunder where there are adverse parties the record in the Patent Office shall be admitted in whole or in part, on motion of either party, subject to such terms and conditions as to costs, expenses, and the further cross-examination of the witnesses as the court may impose, without prejudice, however, to the right of the parties to take further testimony. The testimony and exhibits, or parts thereof, of the record in the Patent Office when admitted shall have the same force and effect as if originally taken and produced in the suit.

Judicial Code, section 128, U. S. C., Title 28, section 225:

(a) Review of final decisions. The circuit courts of appeal shall have appellate jurisdiction to review by appeal final decisions—

First. In the district courts, in all cases save where a direct review of the decision may be had in the Supreme Court under section 345 of this title.

STATEMENT OF POINTS

The claims in suit are refused as not defining invention, and therefore not patentable, over the Vogel patent 2,094,480 and the Backer patent 2,157,884. This is believed to be error for the reasons:

1. Even if the Vogel and Backer patents were available against applicant, applicant's accomplishment was invention, and the claims define invention, and are patentable.

2. Neither of the patents to Vogel and Backer is in any sense prior art, or any sense any statutory bar, or therefore entitled to be regarded against applicant in any respect whatsoever.

SUMMARY OF ARGUMENT

The subject matter is a triangle cross-section electric heating element and a process of manufacture.

The triangle cross-section provides increased facility for dissipation of the heat, permitting larger heating capacity in a given element, and substantially reducing failure of the elements.

The process of manufacture provides a method of making the triangle elements, including the formation first to a different intermediate cross-section, and then to the final cross-section.

Each of the article claims in suit, and all but one of the process claims in suit, specify the triangle cross-section.

The remaining process claim specifies the formation in two successive stages.

Any of the claims in suit are refused only as not reciting invention, and therefore not patentable, over the patents to Vogel 2,094,480 and Backer 2,157,884.

The principal reliance is on the patent to Backer, showing several cross-sections, of which the one relied on is that shown in Figure 4, which is semi-circular.

The problem was of long standing. The semi-circular form was tried, and was not the solution, and independent determination corroborates that this conclusion was correct. Further, so far as the semi-circular form may be considered to resemble the triangle cross-section, the Backer patent teaches directly that applicant's solution would be impossible. In any event it was not to be expected.

Therefore the difference is the distinction between success and failure, and not within the skill of the art, and all of the article claims in suit, and all but the one of the process claims in suit, in fact do define invention, and are patentable, over the patent to Backer.

The Backer patent does not show or suggest the formation in two successive stages as recited in the remaining process claim in suit, and therefore that claim likewise defines invention and is patentable over the patent to Backer.

The Vogel patent is relied on only in an auxiliary capacity, as showing a further feature included in some of the claims in suit. With the failure of the Backer patent, the combination of the two patents also fails. However, in any event the disclosure of the Vogel patent contributed nothing.

Thus all of the claims in suit do define invention, and are patentable, over both the patents to Vogel and Backer.

In another respect, applicant was prior to both Vogel and Backer, in everything in any way material to any of the claims in suit, and therefore the sole ground of refusal is entirely non-existent.

ARGUMENT

The claims in suit disclose a triangle cross-section electric heating element and a process of manufacture. (The applications, Exhs. 1 and 2, Jt. App. 43-70 and 71-94a.)

In the course of the proceedings in the District Court it appeared that certain of the claims in suit might be interpreted otherwise than had been intended, and those claims have been withdrawn. Also the requirement for division now has been accepted.

Therefore the claims now in suit are those appearing in the printing of the Complaint, paragraphs 7 and 8. (Jt. App. 3-8.)

Likewise any of these claims are refused only as not reciting invention over the patents to Vogel 2,094,480 and Backer 2,157,884. (Findings, paragraphs 6-13, Jt. App. 12-13.)

However, each of the article claims in suit specifies the triangle cross-section, for example (Jt. App. 4):

37. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

With one exception, each of the process claims in suit also specifies the triangle cross-section, for example (Jt. App. 7-8):

10. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than the perimeter of the original cross-sectional outline of said portion while the length of said portion is unaltered.

The remaining process claim in suit is directed to the feature of side-pressing the element first to an intermediate shape and then to the final shape, to avoid difficulty in production, as follows (Jt. App. 7):

4. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

In this situation, in plaintiff's view, each of the claims in suit does recite invention over the patents to Vogel and Backer.

However, also the patents to Vogel and Backer are not available against the claims in suit.

Invention

The prior tubular elements were round in cross-section, as indicated in the preliminary Figures 1 and 2 of the drawings of the applications in suit. (Jt. App. 15-16, 26, and for the drawings, 69 and 94.)

These elements were sponsored by General Electric Company, and by its subsidiary, Edison General Electric Appliance Company, and this sponsorship compelled a certain degree of acceptance. (Jt. App. 16.)

However, these elements were not satisfactory. The volume of the refractory was excessive, particularly compared to the surface area of the element. At best these elements afforded only line contact with the cooking vessel or other object to be heated. Further, in use they warped, after which the entire contact was at possibly only three spaced places. (Jt. App. 16-17, 35-36.)

Thus the amount of heat that could be designed into the prior round elements was sharply limited. They did not provide any adequate facility for conducting the heat from the resistor wire, the resistor wire became overheated, and soon the elements failed. (Jt. App. 17-18.)

Further, these prior round elements came on the market several years previous to 1922, so that the problem was of long standing, and faced by at least two companies having adequate facilities for research and correction, if the solution were merely a matter of skill in the art. (Jt. App. 15-16, 26.)

Nevertheless the entire citations, against any of the claims in suit, are the Vogel patent 2,094,480, September 28, 1937, and the Backer patent 2,157,884, May 9, 1939. (Jt. App. 43.)

The Backer patent does not claim any cross-section, but is directed entirely to a proposed method of forming the refractory within the sheath. Instead of introducing already formed powdered magnesium oxide, Backer proposes to insert metallic magnesium, and then employ steam to convert the metallic magnesium into magnesium oxide in position in the sheath. (The patent, Jt. App. 106-109, and particularly the claims, 109.)

None of the cross-sections illustrated in the Backer patent have ever come into commercial use. (Jt. App. 24, 36.)

Further, Backer states specifically, that even his method of deformation "could not be successfully used" for elements employing powdered magnesium oxide, since "the resistance coil would not deform with the tube, but would have a tendency to remain circular, and therefore cut through the insulation layer or reduce its thickness too much," exactly what applicant discovered is not the fact. (Jt. App. 109, left hand column, lines 29-41.)

Consistently, none of the cross-sections illustrated in the drawing of the Backer patent do afford any solution of the problem.

The form shown in Figure 1 obviously is so flat that it would have entirely insufficient resistance to warping. The forms shown in Figures 2, 3, and 5, obviously provide no flat contact surface whatsoever. Likewise none of these has been relied on, against any of the claims in suit.

The only cross-section that has been relied on, is the semi-circular cross-section illustrated in Figure 4, on the allegation that it is approximately triangular, or would suggest a triangle.

On the contrary, applicant constructed and tested this semi-circular cross-section, and simply it does not provide sufficient reduction in volume of the refractory, but particularly it possessed definitely insufficient rigidity and resistance to warping. (Jt. App. 20-21, 28-29.)

The determinations by Doctor Johnson confirm these conclusions completely. (Exhibit 10, Jt. App. 100.) The relative ratio of perimeter to cross-section, is fairly high, 1500 against 1670 for applicant's triangle cross-section. However, the relative minimum resistance to bending is far less even than the prior round cross-section, 136 against 260, and against 400 for applicant's triangle cross-section.

Thus the semi-circular cross-section of Figure 4 of the Backer patent superficially may appear to somewhat resemble a triangle, but by the same token, so far as it does, equally it teaches that the triangle cross-section definitely would be entirely unsuitable.

Therefore anything illustrated in the Backer patent was not the solution, did not suggest the solution, and in fact was not even directed or pertinent to the problem.

Therefore the difference between the triangle element and Backer Figure 4 is not merely a casual vicissitude, but is the difference between success and failure, and material and patentable.

Yet all of the article claims in suit, and all but one of the process claims in suit, are specific to the triangle cross-section.

The remaining process claim in suit specifies the feature of forming to shape in two successive stages, obviously not shown in the Backer patent.

Wherefore every claim in suit does recite invention over Backer, even if Backer were prior.

The Vogel patent is relied on only in an auxiliary capacity, as showing deformation after bending, included in some of the claims in suit. It issued to Edison Appliance, and has been adopted by Edison Appliance. (Jt. App. 33-34, and for the identity of the patentee, Jt. App. 102.)

The patent proposed to flatten one or both sides of the element, as shown respectively in Figures 4 and 3 of the drawing of the patent. (Jt. App. 101-105.) Obviously this would afford increased contact between the element and the cooking vessel, that is, so long as the element remained flat, and to this extent it would be an improvement over the prior round elements. (Jt. App. 20, 28.)

However, Vogel had no thought of increase of surface area of the element compared to the volume of the refractory, and in fact the Vogel elements effected very little change in the ratio of the surface area to the volume of the refractory. (Jt. App. 20, 28, 34.)

Further, the flattening, even on one side, materially increased the propensity to warp, so that even though Edison Appliance resorted to the expedient of securing the elements to the support, as shown in the physical Exhibit 9, nevertheless in use the elements continued to warp, and the apparent increase in contact with the cooking vessel in fact did not result. (Jt. App. 20, 28, 34-35.)

Consistently, the Vogel patent also is not directed to any particular cross-section, but entirely to re-distributing the refractory to fill cracks and voids that occurred in manufacture of the elements at Edison Appliance, the purpose for which it was adopted at Edison Appliance, and obviously a different problem entirely. (Particularly the statement of objects, Jt. App. 102, and the claims, Jt. App. 104-105; Jt. App. 34.)

Thus anything illustrated in the Vogel patent made no substantial contribution to the solution of the problem, the Vogel patent also is not even directed to the problem, and there can be no propriety in any combination of the Vogel and Backer patents in any respect in regard to the problem, and particularly under the express statements in the Backer patent, that the proposals of the Backer patent "could not be successfully used" for elements of the very type to which the Vogel patent is specific. (Jt. App. 109, left hand column, lines 29-41.)

Wherefore plaintiff submits, the claims in suit do recite invention, and are patentable, over the patents to Vogel and Backer, even if both patents were prior.

Priority

Further, neither patent is prior. On the contrary, the evidence shows conclusively, Wiegand completed and tested everything pertinent in either the Vogel patent or the Backer patent, and for that matter, also the forms of Figures 2 and 5 of Backer patent, in any event prior to 1935. (Jt. App. 18-21, 26-29, and Exh. 3, physical, and Exhs. 4-5, Jt. App. 95-97.) Yet the earliest date possibly available for the Vogel patent is May 16, 1936. (Jt. App. 102, the filing date.) While the earliest date possibly available for the Backer patent in any event is not prior to May 21, 1935. (Jt. App. 107, allowing the date of the claimed Canadian application.)

Considering the proceedings in the District Court, it seems that the District Court overlooked this point entirely.

Particularly, the relevant evidence is in the testimony of the witnesses Calhoun and Cunningham. However, the Court had re-set the trial for a day on which it appeared Mr. Calhoun could not possibly be present, also it was not desired to request a further postponement, nor was it to be expected that any such request would be granted. Therefore after consultation with counsel for defendant the testimony of the witnesses Calhoun and Cunningham was adduced by deposition, naturally with the expectation of reading the depositions at the trial. Then the Court declined to have the depositions read, and ordered that they be merely received.

At the conclusion of the evidence, the Court allowed counsel five to ten minutes to a side, to sum up, but to be directed to wherein the plaintiff "has something that is not disclosed by the other two patents relied on by the defendant." (Transcript, page 27.) Further, the District Court did not receive briefs.

Subsequently there was no opinion, merely a postcard from the clerk, that judgment would be for the defendant, and directing counsel for defendant to prepare and submit findings and conclusions. Also, in view of the indicated judgment, there was no possible objection to the findings and conclusions prepared by counsel for defendant.

Thus it seems now that the District Court was never aware of this point, and consistently, the findings and conclusions contain nothing directly to this point whatsoever. (Jt. App. 11-14.)

Under the foregoing, it may be that this Court will desire to remand, for decision on this point.

On the other hand, under the circumstance that the evidence on this point was not in the presence of the District Court, but entirely by deposition, it seems that it would be entirely in order for this Court to examine the record in this respect, and reach the conclusion here. (For example, *American Asiatic Co. v. Robert Dollar Co.*, C. C. A. 9, 282 F. 743, at 746.)

In that event, by reason of a predecessor application serial number 236,847, filed October 25, 1938, illustrated by the drawing Exhibits 7-A and 7-B, further neither the Vogel patent nor the Backer patent is any statutory bar. (Jt. App. 25, and for the drawings, Jt. App. 98 and 99.)

Thus plaintiff refers in this respect to substantially the entire testimony of the witness Calhoun (Jt. App. 15-25), the corroborating testimony of the witness Cunningham (Jt. App. 25-31), and to Exhibit 3 (physical), and Exhibits 4, 5, 6, 7-A, and 7-B (Jt. App. 95-99).

Whereupon plaintiff submits, neither the Vogel patent nor the Backer patent, is available against any of the claims in suit, in any respect whatsoever. The only ground of refusal falls completely, in fact, is entirely non-existent.

Conclusion

The claims in suit do recite invention, and are patentable, even if the patents to Vogel and Backer were prior.

In fact Wiegand was prior, at least as to everything in any way pertinent to any of the claims in suit, and the only ground of refusal simply has not even any existence.

Wherefore plaintiff prays the judgment of the District Court be reversed, and the cause be remanded accordingly.

Respectfully,

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Counsel for Plaintiff.

BRIEF FOR APPELLEE

United States Court of Appeals

DISTRICT OF COLUMBIA

APPEAL NO. 9135

EDWIN L. WIEGAND COMPANY, APPELLANT
v.
CASPER W. OOMS, COMMISSIONER OF PATENTS, APPELLEE

APPEAL FROM THE JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA

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United States Court of Appeals
for the District of Columbia
FILED APR 15 1946
Joseph W. Stewart
Clerk

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United States Court of Appeals

DISTRICT OF COLUMBIA

APPEAL NO. 9135

EDWIN L. WIEGAND COMPANY, APPELLANT

v.

CASPER W. OOMS, COMMISSIONER OF PATENTS, APPELLEE

APPEAL FROM THE JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA

BRIEF FOR THE COMMISSIONER OF PATENTS

INTRODUCTION

This is an appeal from the judgment of the District Court of the United States for the District of Columbia (14)[1] dismissing the complaint in Civil Action No. 25718 in which the plaintiff sought to have the Court authorize the issuance of patents containing certain claims of his applications Serial Nos. 361,997 and 390,371 for patents on alleged inventions relating to electrical heating elements. As is correctly stated on pages 3 and 4 of the appellant's brief, the issue here is limited to the question of the patentability of the claims appearing on pages 3 to 9 of the appendix, over the patents to Vogel 2,094,480 and Backer 2,157,884.

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[1] The numbers in parentheses refer to pages of the appendix.

APPELLANT'S APPLICATIONS

Both applications contain the same disclosure. The device disclosed is a heating element for use in an electric cooking range. The element consists of a metal sheath inclosing a mass of refractory heat-conducting electrical insulating material in which is embedded a resistance wire. The heating element is substantially triangular in cross-section. In making the element, a metal sheath of circular cross-section inclosing the refractory material and embedded resistance wire, is deformed by means of dies to the desired substantially triangular cross-section. This results in a compacting of the refractory material. The longitudinal axis of the element may be formed as a plane spiral or other non-rectilinear curve. The ends of the element may extend at an angle to said axis.

THE VOGEL AND BACKER PATENTS

Each of these patents relates to an electrical heating element of the same general character as that of the appellant. The heating elements disclosed in the patents consist of a metallic sheath inclosing a compacted mass of heat-refractory, heat-conducting, electrically insulating material in which a resistance heating wire is embedded. In each patent the element which at first is circular in cross-section, is deformed by pressure to another cross-section having at least one substantially flat side. The deformation of the element results in a compacting of the refractory material. One of the several shapes shown in the Backer patent is substantially semicircular in cross-section. In the

Vogel patent the element is bent longitudinally into a plane spiral and the ends of the element extend at right angles to said plane.

APPEALED CLAIMS

The appealed claims appear on pages 3 to 9 of the appendix. The claims numbered 34, 36 to 41, inclusive, and 45 relate to the heating element and the remaining claims to the process by which it is made.

SUMMARY OF ARGUMENT

1. The appellant has not carried his date of invention back of the effective date of either the Vogel or Backer patent, and these patents are proper references for all that they disclose.

2. The appealed claims define nothing inventive over the Vogel and Backer patents.

ARGUMENT

The appellant appears to argue that, in some way, certain early experiments of his antedate the reference patents. This point was not seriously urged in the lower Court and that Court made no express finding on it and was not requested by the appellant to make one. However, it is inherent in the Court's holding that the appealed claims are unpatentable over the references, that the Court was of the opinion that the appellant had failed to carry his date of invention back of the effective dates of the references.

The filing dates of the applications on which the Vogel and Backer patents were granted are May 16, 1936, and January 16, 1936, respectively. The patents afford conclusive evidence that the inventions which they disclose had been completed at least as early as these filing dates (*The Alexander Milburn Co.* v. *Davis-Bournonville Co.,* 270 U. S. 390). If the appellant is to establish that he is the first inventor of anything shown by these patents, he must show either that he had reduced the thing relied on to practice prior to the filing dates of the applications on which the patents were granted, or that he conceived it prior to such date and coupled his conception, by diligence, with a subsequent reduction to practice (*Lake* v. *Gunn,* 48 App. D. C. 376; *Travers* v. *Foote,* 55 App. D. C. 225). In order to establish reduction to practice, a successful test must be proved (*Liebmann et al.* v. *Newcomb,* 50 App. D. C. 185, 269 Fed. 701; *Pool* v. *Dunn,* 34 App. D. C. 132).

It is quite evident that the appellant's alleged experiments with heating elements of elliptical and semi-circular cross section prior to 1938 were unsuccessful (19, 21, 25, 27). This activity is summed up in the statements of the witness Calhoun (25) that "* * * we decided it was not worth while to endeavor to secure patents on either the elliptical or the flattened form, since neither had been satisfactory" and (21) that, after building semi-cylindrical elements, "we were not long in making the equipment and building the elements, nor very long after that in determining that they were not suitable." Obviously, this work was no more than an abandoned experiment, and, since it is alleged to have been carried out in 1935, and appellant's application

No. 236,847, which provides the earliest reduction to practice by him as to any non-circular element, was not filed until October 25, 1938, and there is no evidence of further attempts to reduce this idea to practice between 1935 and October 1938, it is evident that the appellant was lacking in diligence over this critical period, during which both Vogel and Backer entered the field and reduced their inventions to practice by filing their applications. It is thus clear that the appellant has failed to establish that he is the prior inventor of anything shown by Backer or Vogel.

It is true that some of the appealed claims are drawn to methods of making the heating element, rather than to the element per se. It is apparent, however, that a method of making an article is not successfully performed unless the article made is satisfactory (*Dickinson* v. *Swinehart,* 49 App. D. C. 222, 263 Fed. 474). Accordingly, the appellant's unsatisfactory heating elements are no more evidence of a reduction to practice of the process than of the elements themselves.

LACK OF INVENTION

The principal reference is the Backer patent (106) and Fig. 4 thereof is especially relied on. This patent discloses the idea of deforming a circular tube into any one of a number of other shapes, with a resultant compression of the insulating material with which the tube is filled. The tube also contains a coiled resistance wire embedded in the insulating material as called for in the appealed claims. The patentee explains in page 2, column 2, lines 13 to 32 of his patent that the deformation is carried out in two steps and, on the same page, same column, lines 45 to 50 it is pointed out that the perimeter, after deforming, may be less than it was at the start while the length of the tube is unchanged. The process, therefore, is substantially that recited in the appealed claims. Whether or not the initial deformation produces an oblong shape is immaterial and involves no more than a matter of choice. Moreover, since "oblong" merely means longer in one dimension than another, any deformation whatever of a circle must result in such a shape. Accordingly, the reference in some of the process claims to an initial deformation to an oblong shape, presents no distinction over Backer. The exact amount of pressure used in shaping the tube is, of course, a matter for experimental determination, depending on the kind and size of the materials employed.

Backer does not show his element formed into a complete heating unit, but it is standard practice to form such elements into a spiral or similar shape, lying in one plane, as shown for example by Vogel, and as found in the ordinary electric stove top heating unit, and Backer's element would normally be used in this way. Vogel also shows it to be old to bend the ends of the elements out of the plane of the main portion thereof to form terminals. This is a feature which has no coaction with the specific shape of the element, and its application to the Backer structure would produce no new or unexpected result and would clearly involve no invention.

The principal feature relied on by the appellant in support of both the process and article claims is the alleged triangular shape of his element. The word "alleged" is used advisedly since the appellant does not, in any instance, show an element which is triangular within the geometrical meaning of that word. Each of the figures shown is rounded at each of the corners on its outer surfaces and at least one of the corners on its inner surface. The term triangle must be loosely construed, therefore, or it does not apply to the appellant's structure. Moreover, triangles may be of a great variety of shapes. Three quite different kinds are shown in Figs. 8, 18 and 19 of the appellant's application, and a large number of others may be readily imagined. It is evident, therefore, that the word "triangular" as here used, is very broad and somewhat indefinite.

Fig. 19 of the appellant's application (70) shows a heating element which is described in the specification (56) as triangular. This shape, therefore, comes within the terms of the appealed claims. A comparison of this Fig. 19 with Fig. 4 of the Backer patent shows that there is very little difference between the two. In each case the element has one long straight side and a curved portion opposite the middle of this side. The only difference is that in appellant's Fig. 19 the curved portion is joined to the ends of the long straight side by short straight portions whereas in Backer curved portions are employed for this purpose.

The lower Court found that this difference did not involve invention, and this finding is clearly correct. The difference being slight and apparently arbitrary, it was incumbent on the appellant to show first that it was not obvious to make the change and secondly that some unexpected advantage is derived from it. Neither of these burdens has been sustained.

Backer states (page 2, col. 2, lines 10 to 12 and page 3, col. 1, lines 43 and 44 of the patent) that the tube may be deformed into shapes other than those which he illustrates. In view of this disclosure, the selection of the best form for any particular element is no more than a matter of experimental determination. The triangle is one of the most common geometrical forms and would obviously occur to anyone experimenting in accordance with Backer's suggestion that shapes other than those which he illustrates may be used. It is well settled that mere experimentation along obvious lines is not inventive, no matter how useful the results obtained may be (*Minnesota Mining and Mfg. Co.* v. *Coe,* 69 App. D. C. 217, 99 F. (2d) 986; *Naamlooze etc.* v. *Coe,* 76 U. S. App. D. C. 313, 132 F. (2d) 573). It follows that the appealed claims should not be allowed, regardless of any superiority of the triangular shape over the shapes disclosed by Backer.

Moreover, the appellant has not shown any surprising superiority of the triangular cross-section over other shapes. The rigidity of the triangle as a structural shape is universally recognized in mechanics and engineering, as illustrated by the common triangular wall bracket and by the use of diagonal braces in bridges and other structures, which divide them into a series of triangles. Accordingly it was to be expected that an element of triangular cross-section would be comparatively rigid. The ratio of perimeter to cross section is, as shown by appellant's exhibit 10 (appendix, page 100), merely a matter of degree for the various shapes, and depends on the extent of deformation. If the flattening is carried far enough this ratio could be given almost any value desired, since, if the tube were completely flattened so that its opposite walls contacted each other, the cross-sectional area would be zero and the ratio of the perimeter to this area would be infinite. Obviously, therefore, if the tube of Backer's Fig. 1 were flattened sufficiently the ratio of perimeter to area could be made the same as that of the triangle shown in appellant's exhibit 10. It is not clear, therefore, how this ratio can be material so far as patentability is concerned.

It is also important to note that the appellant's claim of superiority is based on a substantially equilateral triangle, such as is shown in Fig. 8 of his application. None of the claims, however, is limited to this form of triangle. It has not been shown that other triangular shapes, such as that of appellant's Fig. 19, would give the same results as the equilateral triangle. Since the form of Fig. 19 so nearly approaches that of Backer's Fig. 4 it is reasonable to suppose that these two would give very similar results, and no evidence to the contrary has been offered. There is a much wider difference between various forms of triangles than there is between appellant's Fig 19 and Backer's Fig. 4. This is clear from a comparison of the triangles of appellant's Figs. 18 and 19, for example. The appellant's proofs clearly fall far short of establishing that all forms of triangles are superior to the disclosure of Backer's Fig. 4. At best, they merely show that the equilateral triangle is superior. For the reasons given above, it is submitted that the appellant has not shown that even the equilateral triangle was anything more than an obvious modification of Backer's device. However, even if this one form could be held to be inventive, it would not justify the allowance of the appealed claims, which cover a wide variety of shapes which have not been shown to have any superiority over what is disclosed by Backer.

CONCLUSION

It is submitted that the appellant has failed to establish that his invention of anything shown by the Backer or Vogel patent was prior to the filing date of either of the applications on which those patents were granted; and that the appealed claims fail to define anything inventive over what is disclosed by those patents. The lower Court, therefore, properly dismissed the complaint, and the decision appealed from should be affirmed.

Respectfully submitted.

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E. L. Reynolds,
Of counsel.

April 1946.

U. S. GOVERNMENT PRINTING OFFICE: 1946

JOINT APPENDIX

IN THE

United States Court of Appeals

DISTRICT OF COLUMBIA.

No. 9135.

EDWIN L. WIEGAND COMPANY, *Appellant,*

v.

CASPER W. OOMS, Commissioner of Patents, *Appellee.*

Appeal from the District Court of the United States for the District of Columbia.

United States Court of Appeals
for the District of Columbia

FILED MAR 27 1946

Joseph W

CLERK

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IN THE

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JOINT APPENDIX.

I.

PLEADINGS, DOCKET ENTRIES AND OTHER PAPERS DESIGNATED.

1 Filed Aug 28 1944

In the District Court of the United States for the District of Columbia

Civil Number 25718

Edwin L. Wiegand Company, 7500 Thomas Boulevard, Pittsburgh, Pennsylvania, *Plaintiff,*

v.

Conway P. Coe, Commissioner of Patents, Washington, D. C., *Defendant.*

Complaint for Issuance of Patent

Now comes plaintiff, Edwin L. Wiegand Company, and brings this its complaint against defendant, Conway P. Coe, and shows as follows:

1. Plaintiff, Edwin L. Wiegand Company, is a corporation organized and existing under and by virtue of the laws of the Commonwealth of Pennsylvania and having its principal place of business at Pittsburgh, Pennsylvania.

2. Defendant, Conway P. Coe, is Commissioner of Patents of the United States, is sued as such, and is an official resident of the District of Columbia.

3. The jurisdiction of this Court is invoked under the Patent Laws of the United States, and particularly under section 4915 of the Revised Statutes, U. S. C. Title 35, section 63, as amended.

2 4. Plaintiff is the owner, by assignment, of the entire right, title, and interest in, to, and under the inventions disclosed in two applications for letters patent of the United States, by Edwin L. Wiegand, for Electrical Heating Elements, one filed October 21, 1940, serial number 361,997, and the other filed April 25, 1941, serial

number 390,371, and of the entire right, title, and interest in, to, and under said applications.

5. Said application 390,371 is a divisional of said application 361,997, directed to the same subject matter as said application 361,997.

6. Said applications were filed according to the laws of the United States and the rules of the United States Patent Office, and have been prosecuted according to the laws of the United States and the rules of the United States Patent Office.

7. Defendant, Conway P. Coe, by decision of the Board of Appeals of the United States Patent Office dated March 9, 1944, has refused to allow claims 14 through 22, 33 through 41, 44, and 45, of said application 361,997, as follows:

* * * * * * * * * *

6 (34) An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less
7 than ninety degrees relatively to another of said portions, and said two portions making between them an angle of substantially less than ninety degrees; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

* * * * * * * * * *

8 (36) An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respec-

tively making interior angles of substantially less than ninety degrees relatively to another of said portions, and said two portions making between them an angle of at least ninety degrees; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

(37) An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

9 (38) An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulting material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

(39) An electrical heating element, comprising: a metallic sheath having portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral end portion bent so as to extend at an angle to said plane.

(40) An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of said axis; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

(41) An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of the axis; compacted refractory heat-conducting electrical-insulating material disposed within said

sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional out-
line of said inside surface and the cross-sectional out-
11 line of said insulating material conforming to each
other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral portion bent so as to extend at an angle to said planes.

* * * * * * * * * *

(45) An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-
sectional outline of said inside surface and the cross-
12 sectional outline of said insulating material conform-
ing to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of at least one of said wall portions.

8. Also, defendant, Conway P. Coe, by decision of the Board of Appeals of the United States Patent Office dated March 9, 1944, has refused to allow claims 2 through 5, 10, 12, and 20, of said application 390,371, as follows:

(2) The process of making an electrical heating element which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

(3) The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in
13 refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath to a generally triangular cross-sectional outline.

(4) The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so a to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

(5) The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its orig-
14 inal cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline.

(10) The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded

in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than the perimeter of the original cross-sectional outline of said portion while the length of said portion is unaltered.

(12) The process of making an electrical heating element, which comprises; providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying to said sheath-portion a second die having a surface cooperable with said matrix to deform said sheath-portion to a generally triangular cross-sectional outline, and moving said dies toward each other until said sheath-portion is deformed to a generally triangular cross-sectional outline and the pressure between said second die and the part of the surface of the sheath-portion in contact therewith is of the order of 25 tons or more per square inch of said surface.

(20) The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying to said sheath portion a second die having a surface cooperable with said matrix to deform said sheath-portion to a generally triangular cross-sectional outline, the cross-sectional perim-

eter of the cavity left when said dies are brought together being such that when said dies are brought together the cross-sectional perimeter of said generally triangular cross-sectional outline is less than the perimeter of the original cross-sectional outline of said sheath; and moving said dies toward each other until said sheath-portion is deformed to said generally triangular cross-sectional outline.

16 9. On the contrary, the subject matter of the said claims is the new and useful invention of said Edwin L. Wiegand, not known or used by others in this country before his invention thereof, not patented or described in any printed publication in this or any other country before his invention thereof or more than one year prior to the filing of said application 361,997, and not in public use or on sale in this country for more than one year prior to the filing of said application 361,997, not patented in any foreign country on any application filed more than twelve months prior to the filing of said application 361,997, and not abandoned, and said decisions and refusals are in error, and the said claims are patentable, and should be allowed.

10. No appeal has been taken to the Court of Customs and Patent Appeals from either of said decisions.

WHEREFORE plaintiff prays that this Court authorize and direct the Commissioner of Patents to allow the said claims, and to issue to plaintiff latters patent of the United States containing said claims.

Respectfully,

EDWIN L. WIEGAND COMPANY,

HADLEY F. FREEMAN,
Attorney for Plaintiff,
1310 Hanna Building,
Cleveland, Ohio.

NELSON J. JEWETT,
Solicitor for Plaintiff,
850 Munsey Building,
Washington, D. C.
DI. 2118.

* * * * * * * * * *

17 Filed Sep 12 1944

Answer to Complaint

To the Honorable the Justices of the District Court of the United States for the District of Columbia.

1, 2, 3, 4, 5, 6. Defendant admits the allegations of paragraphs 1, 2, 3, 4, 5, and 6.

7. He admits that by the decision rendered by the Board of Appeals on March 9, 1944 he has refused to allow claims 14 to 22, inclusive, 33 to 41, inclusive, 44, and 45 of the application of Edwin L. Wiegand No. 361,997, which was filed in the Patent Office on October 21, 1940. He admits that said claims are as set out in paragraph 7.

8. He admits that by the decision rendered by the Board of Appeals on March 9, 1944 he has refused to allow claims 2 to 5, inclusive, 10, 12, and 20 of the application of Edwin L. Wiegand No. 390,371, which was filed in the Patent Office on April 25, 1941. He admits that said claims are as set out in paragraph 8.

18 9. He admits that in said application Edwin L. Wiegand made averments corresponding to the allegations of paragraph 9. He denies that such allegations are sufficient to justify the issuance of a patent on application No. 361,997 with any of the claims set out in paragraph 7 or on application No. 390,371 with any of the claims set out in paragraph 8. He denies that the decisions of the Board of Appeals or his refusal to issue patents are in error. He denies that any of said claims is patentable and denies that any of them should be allowed. He states that none of the claims of application No. 361,997 as set out in paragraph 7 is patentable in view of the following prior patents:

Ayer et al	905,045	Nov. 24, 1908
Cubitt	1,019,426	Mar. 5, 1912
Cook	1,174,548	Mar. 7, 1916
Woodson	1,705,696	Mar. 19, 1929
Kercher et al	1,835,602	Dec. 8, 1931

Vogel	2,094,480	Sept. 28, 1937
Backer	2,157,884	May 9, 1939
British patent	418,155	Oct. 19, 1934.

and for the reasons given by the Examiner in his statement to the Board of Appeals and in the decision rendered in said application No. 361,997. He further states that none of the claims of application No. 390,371 as set out in paragraph 8 is patentable in view of the following prior patent:

Backer	2,157,884	May 9, 1939.

and for the reasons given by the Examiner in his statement to the Board of Appeals and in the decision rendered by the Board of Appeals in said application No. 390,371. Copies of said statements of the Examiner and of said decisions by the Board of Appeals will be furnished at the trial.

Profert of copies of the aforesaid patents is hereby
19 made.

10. He admits the allegation of paragraph 10.

W. W. Cochran,
Solicitor, U. S. Patent Office,
Attorney for Defendant.

* * * * * * * * * *

21 Filed May 21 1945

Findings of Fact

1. This is an action under Section 4915 R. S. (U. S. C., title 35, sec. 63), in which plaintiff, the assignee of the patent application Nos. 361,997 and 390,371, of Edwin L. Wiegand, relating to Electrical Heating Elements, seeks a judgment which would authorize defendant, the Commissioner of Patents, to issue to plaintiff a patent on application No. 361,997, with claims 14 to 22, inclusive, 33 to 41, inclusive, 44 and 45 thereof, and a patent on application No. 390,371, with claims 2, 3, 4, 5, 10, 12 and 20 thereof.

2. Plaintiff has withdrawn claims 14, 33, 35 and 44 of application No. 361,997.

3. Both applications contain the same disclosure. The device disclosed is a heating element for use in an electric cooking range. The element consists of a metal sheath inclosing a mass of refractory heat-conducting electrical insulating material in which is embedded a resistance
22 wire. The heating element is substantially triangular in cross-section. In making the element, a metal sheath of circular cross-section inclosing the refractory material and embedded resistance wire, is deformed by means of dies to the desired substantially triangular cross-section. This results in a compacting of the refractory material. The longitudinal axis of the element may be formed as a plane spiral or other non-rectilinear curve. The ends of the element may extend at an angle to said axis.

4. Claims 33 to 41, inclusive, and 44 and 45 of application No. 361,997, recite the heating element in its completed form. Claims 14 to 22, inclusive, of application No. 361,997, and claims 2, 3, 4, 5, 10, 12 and 20, of application No. 390,371, recite the process of making the element.

5. The Patent Office, in its action on application No. 361,997, made a requirement for division between the group of claims which recite the heating element and the group of claims which recite the process of making it. It appears that the heating element could be made by another process than that recited in the process claims, and the process could be used to produce articles other than plaintiff's heating element. The requirement of division was therefore proper under the Patent Office Rules of Practice Nos. 41 and 42.

6. At the trial defendant relied only on the following prior patents:

Vogel,	2,094,480,	Sept. 28, 1937,
Backer,	2,157,884,	May 9, 1939.

7. Each of these patents relates to an electrical
23 heating element of the same general character as that of the plaintiff. The heating elements disclosed

in the patents consist of a metallic sheath inclosing a compacted mass of heat-refractory, heat-conducting, electrically-insulating material in which a resistance heating wire is embedded. In each patent the element which at first is circular in cross-section, is deformed by pressure to another cross-section having at least one substantially flat side. The deformation of the element results in a compacting of the refractory material. One of the several shapes shown in the Backer patent is substantially semi-circular in cross-section. In the Vogel patent the element is bent longitudinally into a plane spiral and the ends of the element extend at right angles to said plane.

8. The result obtained by pressing the element into the substantially triangular cross-sectional form claimed by plaintiff differs only in degree from the result obtained by Backer in pressing the element to a substantially semi-circular cross-sectional form.

9. The claimed triangular form recited in the claims at bar involves no invention over the semi-circular form shown by Backer.

10. The process claims at bar recite nothing amounting to an invention over the processes disclosed by Backer and Vogel.

11. In view of the Vogel patent no invention was required to make the element disclosed by Backer of non-rectilinear form longitudinally, or to bend the ends of the element as claimed.

24 12. None of the claims at bar recites an invention over the prior art patents to Backer and Vogel.

13. None of the claims at bar is patentable over the prior art patents to Backer and Vogel.

Conclusions of Law.

1. Plaintiff is not entitled to a patent containing any of the claims set out in the complaint, of either of the applications in suit.

2. The complaint should be dismissed with costs against the plaintiff.

May 21st, 1945.

Daniel W. O'Donoghue,
Justice.

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25 Filed May 21 1945

Judgment

This action came on to be heard at this term and thereupon upon consideration thereof, it is this 21st day of May, 1945,

Adjudged that the complaint be and it is hereby dismissed, with costs against the plaintiff.

Daniel W. O'Donoghue,
Justice.

• • • • • • • • • •

27 Filed Aug 18 1945

Notice of Appeal

Notice is hereby given this 18th day of August, 1945, that Edwin L. Wiegand Company, hereby appeals to the United States Court of Appeals for the District of Columbia from the judgment of this Court entered on the 21st day of May, 1945, in favor of The Commissioner of Patents, then Conway P. Coe, now Casper W. Ooms, against said Edwin L. Wiegand Company.

Hadley F. Freeman,
Attorney for Appellant,
1310 Hanna Building,
Cleveland, Ohio.

Nelson J. Jewett,
Solicitor for Appellant,
Munsey Building,
Washington, D. C.

• • • • • • • • • •

II.

DEPOSITIONS AND TESTIMONY DESIGNATED.

33 **Ernest N. Calhoun**, being first duly sworn, on examination by Mr. Freeman, on oath deposes as follows:

Q. Please state your name, age, and residence. A. Ernest N. Calhoun, age 49, residence 211 Lingrove Place, Pittsburgh, Pennsylvania.

Q. You are president of plaintiff Edwin L. Wiegand Company? A. I am.

Q. What has been your connection with the Wiegand Company? A. Sales manager and treasurer from 1922 to 1943, and president from 1943 to date.

Q. Over the period while you were sales manager and treasurer of the company who was president of the company? A. Mr. Edwin L. Wiegand.

Q. The same Edwin L. Wiegand who is the applicant in the applications in suit, Exhibits 1 and 2? A. Correct.

Q. Is Mr. Wiegand still interested in the company? A. Yes; but due to previous serious illness he spends the winters in the South, to avoid the effects of the cold weather. At present he is at Miami, Florida.

Q. During the period you were sales manager and treasurer of the company to what extent were you familiar with the activities in connection with new developments? A. I kept in very close touch with all such activities,
34 because I was interested in our products being supreme.

Q. Were you in close touch with the various activities relating to the developments disclosed in the applications in suit, so that you know in regard to those activities of your own knowledge? A. Very definitely.

Q. The develpments of the applications in suit relate to what are known as tubular electric heating elements? A. Correct.

Q. Have tubular electric heating elements been on the market in any event from the time you came with the Wiegand Company, in 1922? A. Yes, and for some years previously. That is, tubular elements generally. Not the triangle element, which was developed by Mr. Wiegand.

Q. What was the cross-section of those elements? A. Round. They were long, and round in cross-section.

Q. As shown for example in the preliminary Figures 1 and 2 of application 361,997, Exhibit 1? A. Correct. Referring to the preliminary Figures 1 and 2 of application 361,997, the prior tubular heating elements included a long tubular metal sheath, such as the sheath 30, the actual length of which was of the order indicated by Figure 10, and which was round in cross-section, as shown in Figure 2. Within the sheath was a coiled resistance wire, such as the wire 31, extending between terminals at the two ends of the element, indicated at 33, and embedded in granular refractory material, indicated at 32, such as powdered magnesium oxide.

In operation, the terminals 33 are connected to a source of electric current, and the current passing through the resistance wire 31 is converted into heat. The refractory material 32 is required to serve the double purpose, both to insulate the resistance wire 31 electrically, and also to conduct the heat from the resistance wire 31 to the sheath 30, from which it is transmitted to the object to be heated, such as a cooking vessel resting on the element, or usually on two elements interposed one within the other.

Q. Were these elements successful? A. In the sense that they stayed on the market, yes. They were sponsored by General Electric Company, and by its subsidiary, Edison General Electric Appliance Company, and included in their electric ranges, and such backing naturally compelled a certain degree of acceptance. However, practically all of the other range manufacturers used our sheet metal sheathed elements, which of course were not tubular elements at all, but an entirely different process.

Q. What were the disadvantages of the prior tubular elements, particularly as applied to range units? A. To answer that question let me explain that the funda-

36 mental requirement is to conduct the heat from the resistance wire. While we speak of the refractories used in electric heating elements as high heat conducting, in fact they are poor heat conducting compared for example to the metal sheath. Therefore it is important that the volume of the refractory be as small as possible. Then there is the further problem of getting the heat away from the element, by reason of which it is desirable to have the area of the exterior surface of the element as large as possible, that is, without increasing the content or volume. Therefore we may combine these two factors into the single requirement of large ratio of area of the exterior surface of the element, compared to volume of the refractory.

Then as applied to range units, and also to many other uses, with the object to be heated, such as a cooking vessel, resting on the element, or usually on two elements interposed one with the other, obviously it is desirable that the element or elements have a substantial flat contact surface for conduction of the heat directly from the element to the cooking vessel or other object to be heated. At the same time it is important that that surface remain flat, which is not accomplished if the element becomes warped, and therefore it is imprtant also that the element have high rigidity, in all directions.

Therefore the prior tubular elements definitely had too large a volume of refractory, and too small an area of
37 exterior surface, or combining the two, too small a
ratio of exterior surface to volume of refractory. The prior tubular elements also had merely line contact between the element or elements and the cooking vessel, and insufficient rigidity, so that the elements warped, resulting in contact at possibly only three points. Those were the principal disadvantages, resulting in insufficient provision for conducting the heat away from the resistance wire.

Q. What is the result of insufficient provision for conducting the heat away from the resistance wire? A. Obviously, the resistance wire becomes over-heated, and the element burns out, and must be replaced.

Q. Then the amount of heat that can be provided is determined by the ability to take the heat away from the resistance wire? A. Very definitely. Within the limits of ability to take the heat away from the resistance wire, there is no limit on the amount of heat that can be generated in the resistance wire itself. Therefore, other things being equal, the amount of heat that can be designated into the element is determined by the ability to conduct the heat away from the resistance wire.

Q. And that is governed by the factors you have stated? A. Correct; the ratio of the exterior surface of the element to the volume of the refractory, and the extent of the contact between the element or elements and the vessel or other object to be heated, as to both of which the round
38 element shown in the preliminary Figure 2 did not qualify.

Q. Can you identify this device Exhibit 3? A. Yes, sir; it embodies an idea Mr. Wiegand had, of reducing the volume of the granular refractory electrical insulating material by side-pressing the tube, re-forming the tube into an elliptical cross-section, which was of considerably less volume.

Q. Please describe the operation, referring to this photostat Exhibit 4. A. The operation started with a round tube, as shown in the upper part of the photostat, marked *R*. The wire was inserted into this tube, extending between the two terminals, marked *T*. Then a mica washer was inserted in one end, surrounding the terminal at that end, to close the end and centralize the terminal. The tube was then mounted vertically, with the open end up, and with the terminal at that end held in central position. The refractory was then introduced through this open end. Then a second mica washer was inserted surrounding the terminal to close that end and hold that terminal in central position. The unit was then placed between dies which were formed to the elliptical shape, and was then side-pressed under heavy pressure. This re-formed the tube to the elliptical shape, as shown in the lower part of the photostat, marked *E,* which is of considerably less cross-section from the original round tube, producing the result illustrated by Exhibit 3.

39 Q. Have you compared the showing in the lower part of the photostat Exhibit 4 with the device Exhibit 3, and do the views in the lower part of the photostat show the actual device Exhibit 3? A. Yes, sir, that is correct.

Q. Were some of these devices actually made and tested? A. Yes, quite a number of these devices were actually made and tested. This was probably two or three years after we moved to our present location, which was in 1929.

Q. Do you know definitely that it was prior to 1935? A. Absolutely.

Q. Is the device Exhibit 3 one of the devices made and tested at that time? A. Definitely; and I might add, it carries the test number, stamped on one of the terminals, test number 503, also the number 8, showing that it was number 8 of that test.

Q. What is the fact as to whether the operation was satisfactory? A. Well, the side pressing reduced the volume of the refractory to some extent; however, the elliptical shape is not suitable for a heating element.

Q. Why? A. One reason, it still has too large a cross-section compared to the circumference, or, in other words, too large a volume of refractory compared to the exterior surface. Another reason, it is not sufficiently rigid 40 in the narrow plane, and therefore will warp. A third reason, it does not provide any flat surface. Therefore, the same as with a round element, the cooking vessel, or other object, would be in contact only along a line, and after the element had warped, as it surely would, the vessel or object would be in contact only at possibly three separate points.

Q. At generally the same period was there any other proposal of side-pressing an element? A. Yes; Mr. Wiegand suggested side-pressing to produce a flat on one or both sides.

Q. As shown in the Vogel patent 2,094,480? A. Correct.

Q. Did the Wiegand Company actually make and test elements as shown and described in the Vogel patent 2,094,480? A. Yes, sir.

Q. Do you know definitely that that also was prior to 1935? A. Yes, definitely.

Q. Were those elements satisfactory? A. They were better than an element having the elliptical shape, in that they did provide a flat contact surface. However, they also had much too large a volume of refractory compared to the area of the exterior surface. Also, if they were flattened enough for the flat to be of any value, they would be even less rigid in the narrow plane, and would warp even more.

41 Q. Is there any difference in these respects between the forms shown in Figures 3 and 4 of the Vogel patent? A. No net difference. The form shown in Figure 3 would somewhat reduce the volume of the refractory compared to the surface area, but still nowhere sufficient to be satisfactory. On the other hand, it would to an even larger degree reduce the rigidity in the vertical plane, and increase the certainty of warping. As previously stated, any construction to be satisfactory must have both low ratio of volume to surface area and also high rigidity in all directions.

Q. Prior to that same period had Mr. Wiegand ever suggested making an element semi-cylindrical, that is, semi-circular in cross section? A. Yes. That was several years previous. His idea was to side-press the element to semi-circular cross section. Further it was his idea to assemble two such semi-circular elements with their flat faces together, thus forming a round or cylindrical unit.

Q. Were such elements made and tried? A. Yes. We made up the forms and molds, and made several of the semi-cylindrical elements, and we put some of them together as described.

Q. Can you fix the date when that occurred? A. Yes. I have found one of the drawings, our drawing number 469.

Q. Is this print Exhibit 5 a print of that drawing?
42 A. Yes. It is a duplicate of the drawing, drawing 469, completed 6/22/28, which is June 22, 1928. The drawing is entitled "Winding Form", but in fact it shows the double mold, for making two of the semi-cylindrical elements simultaneously.

Q. Therefore were these semi-cylindrical elements made and tested in any event by sometime in 1928? A. Yes, definitely. In fact, by the summer of 1928, because we were not long in making the equipment and building the elements, nor very long after that in determining that they were not suitable.

Q. What was the difficulty? A. Referring to the round or cylindircal, the difficulty was as previously stated. Referring to the semi-cylindrical element, or semi-circular section, the ratio of surface area to volume of the refractory is somewhat better than with the round or cylindrical, but still not sufficient. On the other hand, the resistance to bending or warping is much lower. Therefore the slight advantage in the one respect is more than offset by the disadvantage in the other respect, and, as previously expressed, there is no net improvement, and in fact a net disadvantage.

Q. Therefore those suggestions accomplished nothing? A. Nothing whatsoever, except to show that definitely they were not suitable.

Q. Now, at any of these times was there any sug-
43 gestion of any construction that would be satisfactory? A. No. In fact, it was our conclusion that there was no satisfactory construction.

Q. Was there anything further? A. Not at that time, but, of course, several years later Mr. Wiegand suggested the triangle element.

Q. As shown in Figure 8 of the drawings of each of the applications in suit? A. Correct; and naturally we recognized that this would provide a satisfactory flat surface for contact, and Mr. Wiegand stated that he believed it would meet the other essential requirements, and therefore we made dies, and made several of the elements, and tried them.

Q. What was the result? A. The elements were extremely rigid, that is, in every direction, and were highly satisfactory also in regard to large surface area compared to volume of refractory.

Q. Can you fix the date when this occurred? A. Yes, I can fix it very closely from our drawing, which I have here, drawing AC-3721.

Q. Is this print Exhibit 6 a print of that drawing? A. It is. It is a duplicate of our drawing AC-3721, dated 10-18-37, which is the date the drawing was completed, October 18, 1937. The dies were completed, and the first elements were made and tested, within a week from that date, at the very latest.

44 Q. That is, the elements were made and tested in any event by October 25, 1937? A. Correct.

Q. Did you then go into production on the triangle element? A. No; the element was satisfactory, but we had difficulty in forming it. In too large a percentage the pressing rendered the element unsuitable in one way or another. Therefore there is another factor, it is necessary not only that the cross-section be correct in itself, but also that it be such that the elements can be made. Therefore we had the correct cross-section, but it remained to devise a method of making the elements in that cross-section, and it was not until some time later that that difficulty was overcome.

Q. What occurred then? A. At that later time Mr. Wiegand suggested to re-form the element in two steps, first into the elliptical shape, which in itself had been unsatisfactory, then coil or bend the element into the desired configuration, bending it in the direction of the minor axis, and then re-form it to the triangle shape.

Q. That is, side-press the element from the round cross-section shown in Figure 2 of the drawings of the applica-

tions in suit, Exhibits 1 and 2, first to the somewhat oblong or elliptical section shown in Figure 5, then coil it in the direction of the minor axis, and then re-form it as indicated in Figures 6 and 7, into the triangle element shown in
45 Figure 8? A. Correct. Resulting in increase in the ratio of the exterior surface of the element, to the volume of the refractory, to an entirely different order. Resulting also in the provision of a broad contact surface, and of an increase in rigidity such that the element does not warp, and therefore in an increase of contact between the element or elements and the object to be heated, also to an entirely different order. With the result that the triangle element was and has continued to be highly satisfactory.

Q. And these results follow from the triangle cross-section? A. Very definitely; and apparently no other cross-section will yield any results that are even comparable. However, from our previous experience it certainly was not to be expected that the triangle element would yield any favorable results. Therefore there may be some other satisfactory cross-section, but if there is, we do not know it.

Q. I notice that the Vogel patent 2,094,480 issued September 28, 1937, whereas the drawing Exhibit 6 is October 18, 1937. Therefore did Mr. Wiegand or anyone in the Wiegand Company have a copy of or know about this Vogel patent prior to the completion of the drawing Exhibit 6? A. No, I am very certain none of us was aware of the Vogel patent, because the first we knew of this Vogel patent was after we had already made the first triangle elements, and we noticed particularly that the Vogel patent went back to what we previously had found unsatisfactory.

46 Q. Referring to the Backer patent 2,157,884, I notice that Backer refers to the form shown in Figure 2 as elliptical; is that correct? A. Yes; and in fact it is substantially identical with the form shown by this Exhibit 3, which of course we also previously had found unsatisfactory.

Q. Based on your knowledge and experience in the art, would any of the other forms shown in the Backer patent be satisfactory? A. No. The form shown in Figure 1 is so flat that it would readily warp and twist, the form shown in Figure 3 has altogether too great a volume compared to the surface area, and the form shown in Figure 4 possesses the disadvantage of Figure 1 plus the disadvantage of Figure 3.

Q. Based upon your knowledge of the industry, have any of the forms shown in the Backer patent ever been made and sold commercially? A. No.

Q. Based on your knowledge and experience in the art, is there anything in either the Vogel patent or the Backer patent or both, or in any of these other patents set up in the answer in this suit, that does or would disclose or suggest a triangle element, or that a triangle element would overcome the previous difficulties? A. No, definitely not, and in fact the considerable number of shapes shown even
in the Vogel and Backer patents, and the fact that
47 none of them were suitable, would suggest that no
cross-section would or should be expected to be any
better. However, I would like to point out, the Backer patent states directly that it does not apply at all.

Q. Where is that? A. Page 3, first column, beginning at line 29, the patent refers to elements made by the powder process, and then states, at lines 34 and 35.

"My deformation method could not be successfully used for such elements * * *."

Q. Are the elements of the applications in suit made by the powder process? A. They certainly are.

Q. Well then, does the Backer patent teach anything in respect of the developments in suit? A. Nothing whatsoever, except on the negative side, that the entire disclosure of the Backer patent is entirely inapplicable to the developments in suit.

Q. Including the idea of side-pressing? A. Yes, including the idea of side-pressing, and of course including also each and all of the particular shapes.

Q. Referring to the device Exhibit 3, do you know where that particular device Exhibit 3 has been? A. Yes; Mr. Wiegand gave it to you some time after the triangle element was devised, at the time the Vogel patent came to our attention.

48 Q. Do you know why this device Exhibit 3 was given to me at that time? A. Yes; after the Vogel patent issued we considered filing an application on the flattened form shown in the Vogel patent, and including also this previous elliptical form. At that time we still had the dies for the flattened form, and also this specimen of the elliptical form.

Q. Was any application filed, disclosing the elliptical form and the flattened form? A. Yes, such an application was filed. Then later we decided it was not worth while to endeavor to secure patents on either the elliptical form or the flattened form, since neither had been satisfactory, and therefore we filed the present application, and dropped the elliptical form and the flattened form. After that we discarded the dies, and also the test data, and therefore this one specimen Exhibit 3 is all that remains.

Q. By "present application" you mean application in suit, serial number 361,997? A. Correct.

Q. And the other application in suit, serial number 380,371, is a division of application 361,997? A. Correct.

Q. Do these prints Exhibits 7-A and 7-B show the drawings of the previous application as regards the elliptical form, the flattened form, and the triangle element?
49 A. They do; application 236,847, filed October 25, 1938.

Q. Now, what became of that previous application? A. That application was permitted to become abandoned June 27, 1941, in favor of the persent applications.

* * * * * * * * * *

50 **Harry C. Cunningham**, being first duly sworn, on examination by Mr. Freeman, on oath deposes as follows:

Q. Please state your name, age, and residence. A. Harry C. Cunningham, age 47, residence 115 Carnegie Place, Pittsburgh, Pennsylvania.

Q. What has been your connection with plaintiff Edwin L. Wiegand Company? A. I first came with the Wiegand Company in 1921. My present connection has been from June 1, 1928, design engineer.

Q. During that period to what extent have you been familiar with the activities in connection with new developments? A. Naturally I have been intimately acquainted with such activities, in view of my position.

Q. Were you in such touch with the activities relating to the developments disclosed in these applications in suit, Exhibits 1 and 2, so that you know in regard to those activities of your own knowledge? A. Yes, certainly.

Q. The developments of the applications in suit relate to what are known as tubular electric heating elements? A. They do.

Q. Have tubular electric heating elements been on the market in any event from the time you first came with the Wiegand Company, in 1921? A. Yes.

51 Q. What was the shape of those elements? A. Long, and round in cross-section.

Q. As shown for example in the preliminary Figures 1 and 2 of application 361,997, Exhibit 1? A. Yes.

Q. Can you identify this device Exhibit 3? A. I can. It is an idea Mr. Wiegand had, Mr. Edwin L. Wiegand, who at that time was president of the company.

Q. Will you please describe it, referring also to this photostat Exhibit 4? A. The idea was to start with a round tube, shown in the upper part of the photostat, reference *R*, and insert into the tube a wire extending between the terminals *T*. Then the tube was filled with granular refractory material, and with the ends of the tubes closed by mica washers, and the tube crimped to hold the washers in place, then the unit was placed in elliptical dies and pressed under heavy pressure, which re-formed the tube to the elliptical shape, shown in the lower part of the photostat, and present in Exhibit 3. This of course reduced the volume of the refractory, and without reducing the surface area of the tube, and therefore resulted in a lower volume of refractory for the same surface area.

Q. Were any of these devices ever made and tested? A. Yes; and in fact I had charge of making and testing them.

Q. Do you know definitely whether this was prior
52 to 1935? A. Yes, it was.

Q. Do you know that on the basis of recollection? A. On the basis of recollection, and also I have looked up the dates of other work that definitely was later, necessarily was later.

Q. And those show definitely that these units were made and tested prior to 1935?

A. Absolutely.

Q. Is this device Exhibit 3 one of the devices actually made and tested prior to 1935?

A. It is. I can tell that also from the test number, stamped on this terminal.

Q. That is this test number 503?

A. It is. Also the figure 8, showing that this was specimen 8 of that test 503.

Q. Was the operation satisfactory?

A. Not from the point of view of a satisfactory heating element.

Q. Why is the elliptical shape not suitable for a heating element?

A. First, insufficient surface area compared to the volume of the refractory. Second, insufficient rigidity in the minor direction, resulting in warping.

Q. What is the principal use of tubular electric heating elements?

A. For range units, and of course for that use, or any similar use, the elliptical shape would provide only line contact, even before the element warped, and after
53 that would provide contact only at points, and therefore would be no better than the round section.

Q. At generally that same period did Mr. Wiegand have any other suggestion intended to provide more than line contact?

A. Yes; to take a round element and press it to form a flat on one side, or it could be pressed to form two flats, on opposite sides of the element.

Q. As shown in this Vogel patent 2,094,480, Figures 3 and 4?

A. Yes; and we made and tested such elements. I did not have charge of making them, but I knew they were being made, and then I had charge of testing them.

Q. Were those elements also made and tested prior to 1935?

A. Oh, yes, absolutely.

Q. Were those elements satisfactory?

A. No. They did not have sufficient surface compared to the volume of the refractory, and they did not have sufficient rigidity, and as soon as they were heated and warped, then the surface was no longer flat.

Q. Is there any difference in these respects between the form shown in Figure 3 of the Vogel patent and the form shown in Figure 4 of the same patent?

A. Figure 3 the area is slightly greater, but the rigidity is considerably less, so that one offsets the other.

Q. To your knowledge, did Mr. Wiegand ever suggest making an element semi-circular in cross-section?

54 A. Yes. However, that was shortly after I returned, in 1928. That idea was to press the element to semi-circular cross-section, also to assemble two of the semi-circular elements in the form of a cylinder. I designed the tools for that, and supervised the drawings, and also supervised making and testing the elements.

Q. Do you recognize this drawing number 469?

A. I do.

Q. And is this print Exhibit 5 a true and correct print of that drawing 469?

A. It is, showing the mold for making those elements.

Q. I notice the title is "Winding Form".

A. Yes; the draftsman copied the title from the drawing of the Winding Form, and I remember, I intended to have it changed, but then the idea proved unsuitable, and the change was never made.

Q. Has there been any change in that drawing, from the time it was made?

A. None whatever.

Q. And when was the drawing made?

A. Completed June 22, 1928.

Q. As shown in the print Exhibit 5?

A. As shown in the print Exhibit 5.

Q. Were such elements actually made an tested?

A. Yes, we made the tools, and made up quite a
55 few of the elements, and tested them, but they were
not suitable.

Q. What is the difficulty with the semi-circular cross-section?

A. The surface area is still too low, compared to the volume, and the rigidity is very low.

Q. When were these tests completed?

A. Oh, within a month or two of the time the drawing was completed.

Q. In any event by sometimes in the summer of 1928?

A. Yes, absolutely.

Q. At any of these times was there any suggestion of any construction that was or would be suitable?

A. No, none whatever.

Q. Was any conclusion reached?

A. Only that we concluded that there was no suitable construction.

Q. Subsequently has there been any further suggestion?

A. Yes; subsequently Mr. Wiegand suggested the triangle element.

Q. As shown in Figure 8 of each of these applications Exhibits 1 and 2?

A. Yes.

Q. That was several years later?

A. Yes, several years later; I think you have the drawing.

Q. That is this drawing AC-3721?

A. It is.

Q. Has there been any change in that drawing since the time it was completed?

A. No. I made this drawing myself, and there has
56 been no change whatever.

Q. Is this print Exhibit 6 a true and correct print of that drawing?

A. It is.

Q. And when was that drawing completed?

A. October 18, 1937.

Q. Were elements according to that drawing actually made and tested?

A. Yes, the dies were made, and elements were made and tested, within a week or ten days at the most.

Q. That would be not later than October 28, 1937?

A. Not later than that.

Q. Were these elements satisfactory?

A. The elements were satisfactory, but there was trouble in forming to the triangle section, but then later Mr. Wiegand suggested pressing the element first to an elliptical section and then re-forming it to the triangle.

Q. In other words, first press the element from the round cross-section shown in Figure 2 of the applications Exhibits 1 and 2, into the oblong or elliptical section shown in Figure 5, and then re-form it as shown in Figures 6 and 7, into the triangle element shown in Figure 8?

A. Yes; and that overcame the difficulty in manufacture, and then we went into production, and of course this is our entire production of tubular elements, and is highly satisfactory.

57 Q. And these results follow from the triangle cross-section?

A. From the triangle cross-section.

Q. Do you know of any other cross-section that would produce the same or similar results?

A. No; and I was much surprised that the triangle produced them. That is, from our previous experience I would expect that the triangle would be not suitable at all.

* * * * * * * * * *

69 Mr. Freeman. Then I would like to offer the exhibits referred to in the depositions. Exhibits 1 and 2 are certified copies of the applications.

Mr. Cochran. No objection.

The Court. Exhibits 1 and 2.

(Certified copies of applications, marked Plaintiff's Deposition Exhibits 1 and 2, were received in evidence.)

Mr. Freeman. Exhibit 3 is the so-called elliptical unit, and the testimony shows that that was given to me, and therefore I will add that according to my notation here that was given to me November 5, 1937, and has been in my possession from that time until now.

70 The Court. There is no objection?

Mr. Cochran. No objection.

The Court. I will admit that in evidence as Plaintiff's Exhibit No. 3.

(Elliptical unit, marked Plaintiff's Deposition Exhibit No. 3, was received in evidence.)

Mr. Freeman. And then I offer these various photostats as Exhibits 4, 5, 6, 7-A and 7-B, and that completes the deposition exhibits.

(Photostats, marked Plaintiff's Deposition Exhibits Nos. 4, 5, 6, 7-A and 7-B, were received in evidence.)

* * * * * * * * * *

Fred J. Ewald, Jr. was called as a witness for and on behalf of the plaintiff and, having been first duly sworn, was examined and testified as follows:

Direct Examination

By Mr. Freeman:

Q. Please state your name, age, and residence. A. Fred J. Ewald, Jr.; age 39; residence 143 Spring Grove Road, Pittsburgh, Pennsylvania.

Q. And what is your present occupation? A. Production engineer, Edwin L. Wiegand Company.

Q. And that is the corporation the plaintiff in this suit? A. That is right.

Q. How long have you been with the Wiegand Company? A. Since 1941.

71 Q. Is the Wiegand Company engaged in the manufacture and sale of tubular electric heating elements? A. Yes, they are.

Q. Are those the triangle elements shown in the applications in suit, Exhibits 1 and 2? A. Yes, they are.

Q. And shown also in the range unit, Exhibit 8 (indicating)? A. That is right.

The Deputy Marshal. You want this to go in as an exhibit?

Mr. Freeman. Well, I will offer it, yes.

The Deputy Clerk. No. 9?

Mr. Freeman. No. 8.

The Court. One of these was the A and B.

Mr. Freeman. There was a 7-A and 7-B.

The Court. There is no 6 up here.

Mr. Freeman. 6 is the large-size one.

The Court. The one that is marked "8" will be marked 6.

The Deputy Clerk. That is all marked. There is no use to mark them again.

Mr. Freeman. They were all marked, your Honor, by the reporter during the—following the depositions.

By Mr. Freeman:

Q. Over the period that you have been with the Wiegand Company have you been in charge of the production of—

The Court. Just a moment. This last exhibit is Exhibit 8?

Mr. Freeman. 8.

The Court. That piece of mechanism.

(Range unit was marked Plaintiff's Exhibit No. 8 and received in evidence.)

72 By Mr. Freeman:

Q. Over the period you have been with the Wiegand Company have you been in charge of production engineering of the tubular elements? A. I have been.

Q. What has been your previous experience in the design and manufacture of tubular electric heating elements? A. With the Edison General Electric Appliance Company from 1930 until 1937. At that time I went with Tuttle & Kift, and I was with Tuttle & Kift until 1941 when I came to the Wiegand Company.

Q. Are you a graduate engineer? A. Yes, I am. I am a graduate of Armour Institute of Technology, 1927, with the degree of bachelor of science in electrical engineering.

Q. Were Edison Appliance making and selling tubular elements at the time you went with them in 1930? A. Yes, they were.

Q. What were they making at that time? A. At that time they were making the units with the round cross sections.

Q. That is as shown in these preliminary figures 1 and 2 of the drawings of the application in suit? A. That is right.

Q. Later on did Edison Appliance make any change in the construction of their tubular elements? A. Well, in 1936 they started to flatten both sides, and shortly thereafter went to flattening one side of the element.

73 Q. When you say "flattening both sides," do you mean as shown in Figure 3 of the Vogel patent, 2,094,480? A. That is right. Figure 3; and then they flattened one side, is the one shown in Figure 4, which they went to shortly afterwards.

Q. Is there any relation between or connection between Tuttle & Kift and Edison Appliance? A. Well, Tuttle & Kift were an offsheet of Edison Appliance.

Q. Did Tuttle & Kift, when they separated from Edison Appliance, start the manufacture of tubular electric heating elements? A. They started the manufacture of tubular electric heating elements in 1938.

Q. That was about a year afterwards? A. That was about a year after.

Q. That year was spent in development and preparation? A. That is right.

Q. And when Tuttle & Kift started the manufacture of electric heating elements in 1938, what form did they make? A. They used the unit flattened on one side.

Q. As shown in Figure 4 of Vogel? A. As shown in Figure 4 of Vogel.

Q. The same as Edison Appliance made? A. That is right.

Q. Were you acquainted with the purpose of pressing the flat on one or both sides of the elements? A. Yes, I was.

Q. And what was the purpose of doing that? A. The purpose of pressing that unit was to close the cracks
74 that were formed in bending the element into the spiral shape.

Q. Was there any purpose of changing the ratio between the surface area and the volume or of changing the resistance to bending and warping? A. None whatsoever.

Q. Did the side pressing of either one or both sides effect any change in the ratio between the surface area of the element and the volume? A. Well, it did to a slight extent.

Q. Did it effect any change in the resistance of the element to bending or warping? A. Well, the flattened elements had much less resistance to bending, and of course also to warping.

Q. Which change was greater, the— A. Well, the change in resistance to warping was considerably greater, more than offset anything that was gained by increase in ratio of area to volume.

Q. But neither of those changes was any purpose in doing the— A. No, sir.

Q. In making the change? A. No; that wasn't the purpose of the flattening.

Q. I show you this unit marked Exhibit 9 and ask you whether that is the range unit showing the Edison Appliance manufacture flattened on one side. A. It is.

Q. Now, what is the result of insufficient rigidity and resistance to warping, for example, as applied to range units?

(Heating unit was marked Plaintiff's Exhibit 9 for identification.)

75 A. Well, when the unit isn't sufficiently rigid, it has to be anchored to the support, and by either one of two methods. It is sometimes welded and sometimes staked. By staking is meant the forming of the support over a part of the element.

Q. Is that staking illustrated in the range unit, Exhibit 9? A. Staking is shown here; that's right; in which the element is formed over part of the element.

Q. You mean the support is formed. A. I mean the support. That is right. The support is formed over part of the element.

Q. And locks the elements down? A. That's right.

Q. Now, when those elements are heated isn't there some longitudinal expansion? A. Yes, there is.

Q. When they are locked or anchored to the frame, what happens during that longitudinal expansion? A. Well, they eventually take a set, and then we have what we call a warped unit.

Q. Which way do they warp? A. They warp in nearly all directions. But the result is that you no longer have the flat unit, after some period of time.

Q. And what is the effect of that as far as cooking is concerned? A. Well, of course, if the unit is not flat, why, the utensil doesn't make good contact with the unit, and the operation is very unsatisfactory.

76 Q. Is it correct, then, that neither the round tubular elements nor the flattened elements have ever been satisfactory either in respect of ratio of surface area to volume or in respect of rigidity and resistance to warping? A. That is right. That is true.

Q. Now, with the triangle element what is the situation in regard to the necessity of anchoring the element to the frame? A. The triangle element is sufficiently rigid and resistant to warping, it doesn't require supporting or anchoring to the frame.

Q. Is it secured to the frame at all? A. Yes, it is, at one point, simply to hold the elements in place and to locate them.

Q. That is, prevent them from shifting around? A. That is right.

Q. Dropping off when you turn it over? A. That is right.

Q. But not to prevent their warping at all? A. That is right.

Q. That is illustrated by the range unit, Exhibit 8? A. That is right.

Q. Have you been familiar with the various tubular electric heating elements on the market from the time you went with Edison Appliance in 1930? A. Yes, I have been.

Q. Until the Wiegand Company developed the triangle element, what were the tubular elements on the market up to that time? A. Well, they were either round in
77 cross section, flat on both sides, or flat on one side.

Q. Those being the sections that you have previously discussed? A. That is right.

Q. Up to the present time have there ever been on the market any tubular electric heating elements having any of the cross sections shown in any of the figures of the Backer patent, 2,157,884? A. No, there haven't.

Q. Subsequent to the depositions in Pittsburgh last Wednesday, were you requested to investigate the file of the Backer patent 2,157,884 as to whether it contained anything further relating to the part of the specification referred to by Mr. Calhoun, that the forms of the Backer patent could not be successfully used with the elements made by the powder process? A. Yes, I was.

Q. Have you done so? A. Yes, I have.

Q. When did you do that? A. Saturday.

Q. And did you find anything in that respect? A. Yes, I did.

Q. And will you state what you found? A. Well, I found in the files an affidavit reading as follows:

"Moreover, there is no advantage, but rather disadvantages in using an elliptic, square, or semi-circular shape for
the tubular type of element employing powdered in-
78 sulation, such as that set forth in Abbott, et al., pat-
ent No. 1,731,119, of record in my above-identified
application."

Mr. Cochran. May I interrupt to ask if the witness is testifying about something he found in a Patent Office file?

The Witness. That is right.

Mr. Freeman. Yes.

The Witness. That is right.

Mr. Cochran. It seems to me that is not admissible here. He should have brought the copy of the thing itself.

The Court. A witness may not come and testify to what he saw in a paper in the Patent Office. If you want to introduce that in evidence you should have a certified copy of that paper.

Mr. Cochran. I have no objection to obtaining a certified copy and having it submitted to your Honor later. It is all right with me. I do not wish to keep it out.

Mr. Freeman. I know of no reason why the witness may not testify to what he read in the file.

Mr. Cochran. It is not the best evidence of what is there.

The Court. No. Oh, well, I will allow it in.

Mr. Cochran. Subject to comparison to see that it is all true, I will not object to it.

By Mr. Freeman:

Q. Did that statement appear—

The Court. That will go in for the time being.
Mr. Freeman. Yes.

By Mr. Freeman:

Q. Is it correct that that statement that you read appeared in an affidavit by the applicant and patentee
79 Backer? A. That is right.

Q. And what was the date of that affidavit? A. The date on that was April 7, 1937.

Q. And the reference in that statement to "elliptic, square, or semicircular" described the form shown in Figures 2, 3, and 4, respectively, of the Backer patent, 2,157,884? A. That is right.

Mr. Freeman. Direct examination closed.

Cross-Examination

By Mr. Cochran:

Q. May I ask, Mr. Ewald, what was the connection in which such an affidavit was filed? A. What is that?

Q. In what connection was that affidavit filed by Backer in his patent? In what connection was it filed? What was the—it was not just in the file there loose, was it? A. Well, it was in connection with the—I supposed, his application for the issuance of the patent.

Q. You just found that paper loosely fastened in the file, and that is all you— A. There was an affidavit in that file to that extent, yes, stating—

Q. By Backer himself? A. By Backer himself, stating—yes.

Q. Stating that his species, the square and the semi-circular and the elliptical, were no good? A. That is right.

Q. In his own application for patent on those
80 species? A. Insofar as the use of powdered insulation on the tubular type of element.

The Court. Well, of course, the Court has indicated that it is not admissible, you know, to prove anything in that manner.

Mr. Freeman. May I speak to Mr. Cochran?

The Court. If Mr. Cochran insists upon his objection, I shall have to sustain it.

Mr. Freeman. May I speak to Mr. Cochran just a minute?

The Court. Yes.

Mr. Freeman. I can answer his question.

(Mr. Freeman conferred with Mr. Cochran.)

Mr. Cochran. I will have to stand by my objection, your Honor. This is just a part of the entire file, and I do not know what else is in it.

The Court. It was filed in some other patent case over there?

Mr. Cochran. It is the case which the Patent Office is relying on here, the Backer patent; some statement by Backer in an affidavit.

The Court. It was not any paper filed in this case that is before me?

Mr. Cochran. No.

The Court. I have to sustain the objection to that. Of course, an affidavit, first of all, is usually not admissible in evidence because it is an ex parte statement, you see, unless you want to contradict a person. But just somebody who goes to the Patent Office and looks in the file over there
in another case and copies something down from what
81 the affidavit states, and then coming to Court and
telling the Court that is what he read and that it is an affidavit in another case, could not be admissible in evidence under any theory.

Mr. Freeman. I think possibly I have not made this clear, your Honor. The Backer patent is one of the two patents the defendant relies on. Now, in the depositions at Pittsburgh Wednesday Mr. Calhoun, in answer to one of the questions, stated to me that, "Well, Backer says that right in the patent,'' and read an excerpt from the Backer patent. Now, then, as a result of that we wanted to know if there was anything in the file of the Backer patent in the Patent Office that related to that statement, and we got down here and Saturday we went over—

The Court. If there is any such affidavit—in the Backer patent, isn't it?

Mr. Freeman. Backer.

The Court. All right. You should get a certified copy of it and offer it in evidence.

Mr. Freeman. If I had known it beforehand I could have filed a request for admission, but that is ten days, and I knew it Wednesday. Now, I do not see the point. It is part of defendant's records.

The Court. Could you not go over there this afternoon and get a certified copy of this affidavit? Could you not do that, Mr. Cochran?

Mr. Cochran. Could be, by tomorrow afternoon.

The Court. Well, tomorrow, I say, and submit that in evidence.

Mr. Freeman. You understand those are the defendant's records.

82 The Court. Yes, but the defendant's records, just like the Clerk of the Court here would have records in thousands of cases that are here, so a person cannot go into one of those files and read an affidavit and come into Court and say, ''I saw this statement in that affidavit filed in another case.'' I have to sustain the objection.

If Mr. Freeman wishes to offer the affidavit in evidence, you have no objection to that?

Mr. Cochran. I won't object, although I may wish to offer some other things from that same file to counteract it, if there is any such thing; but I will not object to an affidavit, a copy of the thing, produced.

The Court. If you can get it tomorrow, give it to the Clerk.

Mr. Cochran. This paper purports to be an excerpt from an affidavit, at that, you see.

Mr. Freeman. In the meantime may I—

The Court. That is just what this witness has written down and says he copied it from that affidavit in the Backer case; is that right?

The Witness. That is right, your Honor.

The Court. That is not admissible in evidence. That is all I am passing on now.

Mr. Freeman. Yes. May I have an exception to that ruling, please?

The Court. Yes.

Mr. Freeman. Direct examination closed. Oh, you had already started.

83 By Mr. Cochran:

Q. Mr. Ewald, will you refer to the Vogel patent now? The Vogel patent. A. Yes.

Q. Isn't it a fact that Vogel had in mind the compacting and compression of the insulating material by means of the flattening of the casing by pressure? A. Well, the material is compacted before bending, primarily, and then the cracks were formed in the bending.

Q. Well, how do you explain this statement, then, occurring at page 2, the bottom of the first column: "It has been found that this reshaping of the sheath after the heater has been formed redistributes the insulating material 21 and gives it a greater density so that a substantially uniform homogeneous layer of insulating material is provided around and about the conductor"? A. It gives it greater density in that it eliminates the crack. In eliminating voids it will slightly increase the density, yes.

Q. Yes. Now, in the present case, the Wiegand case, isn't that just how Wiegand makes the insulating material denser, by pressure against a circular form, compressing it to a triangular form or other form? A. That is right.

Q. And in both cases there would be a compression of the material as soon as you deform the circle to a triangular or other polygonal form? A. There would be a compression of the material, yes.

Q. And that was not accidental in the Vogel patent,
84 was it? Wasn't that what Vogel says was one of
his objects? A. That is right, yes.

Mr. Cochran. That is all.

(The witness left the stand.)

Mr. Freeman. Call Dr. Johnson.

The Court. So there will be no misunderstanding, I am telling the attorney for the plaintiff that the Court has ruled that you may submit a certified copy of that affidavit that was under discussion and that was filed in the Backer patent case.

Mr. Freeman. Yes, I understand that.

Thereupon **Arthur F. Johnson** was called as a witness for and on behalf of the plaintiff and, having been first duly sworn, was examined and testified as follows:

Direct Examination

By Mr. Freeman:

Q. Please state your name, age, and residence. A. Arthur F. Johnson; 55; residence 1208 Oakcrest Road, Arlington.

Q. What is your position? A. I am professor of mechanical engineering and head of that department at George Washington University.

Q. Have you computed the resistance to bending or warping and also the ratio of surface area to volume of electric heating elements having various cross sections indicated
on this chart, Exhibit 10? A. I have.

85 The Deputy Clerk. 10?

Mr. Freeman. That is not the original I gave him. Will you mark that?

(Chart, comparison of sections, was marked Plaintiff's Exhibit No. 10 for identification.)

By Mr. Freeman:

Q. Are the relative resistances to bending or warping and the relative ratios of surface area to volume as shown on this chart, Exhibit 10? A. Yes, they are, proportional to these figures.

Q. Have you any connection with either party to this suit or any interest in the subject matter or outcome of this suit? A. Absolutely none.

Mr. Freeman. That is all. Direct examination closed.

Mr. Cochran. I have no questions.

The Court. You are excused.

(The witness left the stand.)

Mr. Freeman. Your Honor, I am omitting any testimony in regard to the other six patents, that is, the six patents other than Vogel or Backer, on the understanding that they are not relied on. Is that correct, Mr. Cochran?

Mr. Cochran. That is right.

Mr. Freeman. Plaintiff rests. Oh, I beg your pardon, your Honor. I offer Exhibits 8, 9, and 10.

The Court. It understood that you have offered in evidence all exhibits, numbered 1 to 10, both inclusive; no objection; and all received in evidence.

86 (Plaintiff's Exhibits marked 1 to 10, both inclusive, for identification, were received in evidence.)

* * * * * * * * * *

III.

EXHIBITS.

Plaintiff's Exhibit No. 1.

Mail Division
106 Oct 21 1940
U. S. Patent Office

To the Commissioner of Patents:

Your petitioner, Edwin L. Wiegand, a citizen of the United States and a resident of Pittsburgh, Allegheny County, Pennsylvania, whose post office address is 7500 Thomas Boulevard, Pittsburgh, Pennsylvania, prays that Letters Patent may be granted to him for the Electrical

Heating Elements set forth in the annexed specification; and he hereby appoints as his attorneys Hadley F. Freeman, Donald H. Sweet, and George M. Albrecht, constituting the firm of Freeman, Sweet and Albrecht, Hanna Building, Cleveland, Ohio, and each of them, each and all with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent Office connected therewith.

Signed at Pittsburgh, Allegheny County, Pennsylvania, this 18th day of October, 1940.

Edwin L. Wiegand.

Specification

To All Whom It May Concern:

Be it known that I, Edwin L. Wiegand, a citizen of the United States, and a resident of Pittsburgh, Allegheny County, Pennsylvania, have invented certain new and useful Electrical Heating Elements of which the following is a full, clear, and exact description.

107 My invention relates to electrical resistance heating units or elements of various types comprising a resistor disposed within and insulated from a metal sheath. The principle object of my invention is to provide new and improved electrical heating elements or units of these types, and to provide new and improved processes of making heating elements or units of these types. This application is a continuation in part of my application Serial Number 236,847, filed October 25, 1938.

In the drawings accompanying this specification, and forming a part of this application, I have shown, for purposes of illustration, several forms which my invention may assume, and in these drawings:

Figure 1 is a fragmentary side view of an electrical heating element in an intermediate stage of a process of making an element in accordance with my invention, Figure 2 is an enlarged cross-sectional view taken on the line 2-2 of Figure 1,

Figure 3 is an enlarged fragmentary view of a side of an element in a later stage of a process of making an element in accordance with my invention,

Figure 4 is an enlarged fragmentary side view of an element in the stage shown in Figure 3, but looking in a direction at right angles to the direction in which the element is viewed in Figure 3,

Figure 5 is an enlarged cross-sectional view taken on the line 5-5 of Figure 4, looking in the direction of the arrows,

Figure 6 is a cross-sectional view showing dies ready to press-forge an element to its final cross-sectional form, the element in this instance having a cross-sectional form such as shown in Figure 5,

108 Figure 7 is a cross-sectional view showing the dies and element after the dies have been brought together,

Figure 8 is a cross-sectional view of an electrical heating element embodying my invention,

Figure 9 is a fragmentary perspective view of an electrical heating element in an intermediate stage of a process of making another embodiment of an element in accordance with my invention,

Figure 10 is a plan view of another element embodying my invention,

Figure 11 is a section taken on the line 11-11 of Figure 10,

Figure 12 is a plan view of another element embodying my invention,

Figure 13 is a section taken along the line 13-13 of Figure 12,

Figure 14 is a cross-sectional view of another element embodying my invention,

Figure 15 is a fragmentary plan view of the resistor of the element shown in Figure 14,

Figure 16 is a cross-sectional view of another element embodying my invention, Figure 17 is a fragmentary perspective view of the resistor of the element shown in Figure 16,

Figure 18 is a cross-sectional view of a hot plate showing associated therewith another element or elements embodying my invention,

Figure 19 is a cross-sectional view of a press platen or the like showing associated therewith another element or elements embodying my invention, and

109 Figure 20 is a cross-sectional view of another element embodying my invention.

The element shown in Figures 1 and 2 comprises a rectilinear tubular metal sheath 30 of circular cross-sectional outline, within which is disposed a resistor 31 of desired form, in this instance a helix of resistance wire. The resistor 31 is embedded in refractory electrical-insulating heat-conducting material and desirably uniformly spaced from the inside wall of the sheath 30. Projecting from the ends of the sheath 30 and extending into the insulating material 32 within the sheath a desired distance are terminals 33, these being suitably connected to the ends of the resistor 31. One way in which a metal-sheathed insulated resistor such as shown in Figures 1 and 2 may be produced is to dispose a resistor in a tubular metal sheath so that the resistor is spaced from the inside walls of the sheath, and then introduce refractory insulating material in a granular, or comminuted, or powdered state into the sheath, the insulating material being compacted to any desired degree and in any desired manner. However, my invention is not limited to any particular way of producing such a metal-sheathed insulated resistor. The sheath may be made in any desired and suitable way and assembled with the resistor and insulating material in any desired and suitable manner and in any desired sequence, and the insulating material may be compacted in any desired and suitable manner.

While I prefer not to compact the insulating material 32 by swaging the sheath 30 to a smaller circular outline because this operation draws and elongates the sheath and

has other objections, as will appear, my invention is also applicable in case a metal-sheathed resistor such as shown in Figures 1 and 2 has involved swaging and elongation of the sheath. I prefer to use any method of preliminarily
compacting the insulating material which will not
110 elongate the sheath. I then prefer next to sidepress
the sheath 30 so that its cross-sectional outline is generally elliptical or oval, or, in general, of oblong form. This step is particularly desirable if in its final form the element is to have a non-rectilinear longitudinal axis, but is also useful and desirable even if the element is to remain rectilinear, as will appear. The element shown in Figures 1 and 2 is placed between dies (not shown) having similar matrix portions which when brought together will produce the desired oblong cross-sectional outline. When the element is so side-pressed it may assume an oblong cross-sectional form 30a such as shown in Figure 5, the resistor also assuming a corresponding oblong cross-sectional aspect as shown at 31a. When the element is viewed from the side and in the plane of the major axis *a* of the cross-section 30a it appears as in Figure 3, and when viewed in the plane of the minor axis *b* of the cross-section 30a, it appears as in Figure 4. It will be understood that when the element is in the form shown in Figures 3, 4, and 5, the longitudinal axis thereof still is rectilinear, and as shown in these Figures, the sheath is not side-pressed to an oblong cross-sectional outline throughout its entire length but an end portion 35 at each end may be left of circular cross-section. The portion 30a of oblong cross-sectional outline desirably overlaps a portion of that part of a terminal 33 which is disposed within the sheath 30. The side-pressing operation just described serves to compact the insulating material 32 to a sufficient degree, if it is not already so compacted, to maintain the resistor 31 in a central position within the sheath 30 when the elements is subsequently bent to non-rectilinear form or when it is otherwise worked, or both.

I prefer that the oval or oblong cross-section 30a
111 have a major axis approximately the same as, or at

least not materially greater than, the diameter of the original circular section of the sheath. Dies which bring the sheath to such oval form will of course confine the sheath against free elongation in the direction of the major axis, the oval or oblong shape being secured instead by reduction of the diameter of the sheath in the direction of the minor axis.

Whether or not the element shown in Figures 3, 4, and 5 is bent to non-rectilinear form, that portion thereof which is of oblong cross-sectional outline 30a, or a desired longitudinal part thereof, is placed in the matrix 36 of a die 37 as shown in Figure 6. The matrix 36 is of generally V-shape cross-section having straight sides 38, 39 making between them an angle of 60°, the bisecting line of the angle being normal to the upper flat face 40 of the die. The apex of the triangle formed by the sides 38, 39 is here shown as rounded off by a fillet 41. The element preferably is so placed in the matrix 36 that the major axis of the oblong cross-sectional outline 30a coincides approximately with the line bisecting the angle between the lines 38, 39. Another die 42 having a flat operating face 43 is then brought down against the element until the dies 37, 42 contact as in Figure 7, thereby press-forging the element so that its cross-sectional outline 30b is generally triangular. Thus, the sheath now has two walls 43, 44, (Figure 8), the major portions of which are flat and make between them an agle of 60°, these walls merging in a rounded apex 45 formed by the fillet 41 of the matrix 36. The third wall 46 is substantially entirely flat and makes with the walls 43, 44 angles of 60°
112 respectively. Thus in this particular element the flat portions of the walls 43, 44 are respectively of less cross-sectional extent than the substantially entirely flat wall 46. This is of advantage under some circumstances of use and is the reason the fillet 45 is provided. The radius of the fillet may be as desired, or the matrix may be V-shaped with no fillet at the apex.

The cross-sectional perimeter of the cavity formed by the matrix portion 36 of the die 37 and the face 43 of the die 42 when the faces 40 and 43 of these dies are in contact as in Figure 7, is preferably such that the perimeter of the generally triangular cross-sectional outline 30b of the element is less than the cross-sectional perimeter of the original circular section sheath 30. However, even if the perimeter of the final cross-section shown in Figure 8 is substantially the same as the perimeter of the original sheath, the press-forging of the element to a generally triangular cross-sectional outline results in a very large reduction in cross-sectional area and hence in compaction of the insulating material 32 to very great density. The corners 47, 48 of the cross-section are slightly rounded, the amount of this rounding depending on the relation between the original section of the element and the cavity between the matrix 36 of the die 37 and the face 43 of the die 42.

By pressing the element to generally triangular cross-sectional outline the resistor 31 is reformed so that its cross-sectional aspect 31b is generally triangular as shown in Figure 8, the outline of the resistor being substantially similar to and substantially uniformly spaced from the outline of the inner wall of the sheath, and more
113 nearly so if, as in this instance, the sides of the sheath define a triangle the adjacent sides of which are at 60° to each other. In general, however, in an element triangularly pressed, even if the angles are not all 60°, there is a minimum of undesirable flowing or displacement of the insulating material so that there is a minimum of displacement of the resistor from a symmetrical and uniform position with respect to the walls of the sheath. In the finally pressed element, as shown in Figure 8, the resistor is uniformly spaced from the flat walls 43, 44, 46 but is closer to these walls than it is to the inner wall of the sheath when the sheath is of either the original circular or oblong cross-sectional outlines as in Figures 2 and 5 respectively.

The pressures which I prefer to use to press the element to triangular cross-sectional outline are so high that the

element is to be regarded as not merely deformed or pressed to generally triangular cross-section but as press-forged. I prefer to use pressures of 25 tons per square inch or more. For example, I use a press capable of exerting a pressure such that when the die 42 reaches the end of its stroke the pressure on the surface of the wall 46 of the element is approximately 40 tons per square inch, or more. These pressures are so high that the material is "upset". This is evidenced, for example, by the fact that the resistor 31 is upset and shortened, that is, in effect forged. For instance in the case of a resistor in an initially circular section tubular sheath about 5/16 of an inch to 11/32 of an inch in outside diameter and having a wall thickness of .030 of an inch, the resistor is upset and shortened to such an
extent that its electrical resistance is decreased ap-
114 proximately 8 to 10%, when the element has been
subjected to approximately 40 tons per square inch
as hereinbefore described. The amount of upsetting and decrease will of course depend upon the pressure used and I give the foregoing as an illustration that a press-forging action does take place, and not by way of limitation to particular dimensions or other values.

For any given density or compaction of the insulating material, a triangular section element will contain less insulating material, and hence the sheath will become heated more quickly. Also, for a given initial amount of insulating material, the insulating material in an element embodying my invention is compacted to a super-density, thereby further improving its heat conducting properties. In general, a triangular section element provides the optimum combination of rigidity and strength with a greater ratio of sheath area to element volume and weight. Or stated in another way, it provides a greater ratio of perimeter to sectional area and what is more important, a much larger percentage of perimeter and sheath area may be brought into contact with an object to be heated, and the path of conduction from the opposite extreme point on the sheath is considerably reduced from what it is in, for example, a round section merely pressed somewhat flat on one or both sides. For any one or more of these reasons, heat is more quickly conducted from the resistor to the sheath.

Furthermore, I have made comparative tests on tubular heating elements of circular section and tubular heating elements of triangular section made in accordance with my invention from tubular sheath the same size as the circular section elements and have found that the watts input per square inch of external active surface of the heating element required to fuse the resistor is approximately 15 to 25% higher in the case of the triangular section elements than it is in the case of the circular section elements. Referring to an element of the size hereinbefore mentioned, the resistor fusing point is raised to about 225 watts per square inch of active resistor area. This is because the temperature gradient from the very center of the element section to the outer surface of the sheath is considerably reduced over other constructions. Obviously this feature permits material increase in the maximum normal operating capacity or temperature or both. By way of example, an element of the size hereinbefore mentioned may be normally operated at about 50 to 60 watts per square inch of active surface, in open air at room temperature. By active surface of the sheath I mean the surface of the sheath surrounding and longitudinally coextensive with the resistor.

I prefer first to side-press the element to an oval or oblong cross-section before placing it in the die 37, even if the longitudinal axis of the finished element is to be rectilinear, but I may also place an element of circular section in the die 37 and press-forge it to triangular cross-section.

An element in accordance with my invention may be made of non-rectilinear form in which case I prefer first to provide an element of rectilinear form as shown in Figures 1 and 2, then to side-press it to an oblong cross-sectional outline as shown in Figures 3, 4, and 5 and then to bend an active portion 50 thereof as shown in Figure 9. In

116 bending the active portion 50 I prefer to bend it in the plane defined by the minor axis *b* of the oblong section. If desired an end portion 51, or both end portions, of the element may be bent out of the plane defined by the bent active portion 50, this end portion 51 being joined to the active portion 50 by a bent portion 52 bent in the plane of the major axis of the oblong section, or the terminal zone between the active portion and the extremity of the element may be further pressed round before bending or to any other desirable shape for optimum bending conditions and to secure maximum compactness at this zone. The active portion 50 may be bent in the form of a spiral, or in any other desired form. In any case the bent active portion 50 is placed in a die having a triangular matrix portion, similar to the matrix portion 36, this matrix portion of course having a longitudinal axis corresponding to the longitudinal axis of the bent active portion 50. The active portion 50 is then press-forged to triangular section as hereinbefore described.

An element in accordance with my invention is extremely rigid, though it be long, or have a non-rectilinear longitudinal axis, or both.

Figures 10 and 11 show an element embodying my invention, which has an active portion 53 of spiral form and of triangular cross-section, having wall portions 55, 56, 57, the wall portion 55 defining a place corresponding to the general plane of the spiral. The element has end portions 58, similar to the end portion 51 of Figure 9,
117 which extend transversely of the plane of the spiral and, in this instance, are disposed at that side of the element opposite from the plane of the wall 55.

Figures 12 and 13 show an element embodying my invention, which is similar to the element shown in Figures 10 and 11 except that the element of Figures 12 and 13 has end portions 58a which, while they extend transversely of the general plane of the spiral active portion 53a of the element, are disposed at the same side of the element as the plane defined by the wall 55a corresponding to the wall 55 of the element of Figures 10 and 11.

One use for heating elements such as shown in Figures 10 through 13 is in electric ranges but their use is not limited to that purpose.

It will be noted that if an object to be heated and having a generally plane surface is placed against the wall 55 of the element shown in Figures 10 and 11, there will be a comparatively large area of contact between the object and the element so that under these conditions the object is heated largely by conduction. On the other hand, if such an object is placed against the upper defining surface, as viewed in Figure 13, of the element shown in Figures 12 and 13, the object will be in contact with the apexes of the triangular sections and will be heated mainly by radiation from the walls 56a and 57a of the element. It will be noted that due to the triangular section of the element the bulk of the radiation from the element is directed up-
118 wardly. The bulk of the radiation from the walls 56a, 57a is directed diagonally upwardly in respectively opposite directions considering any given portion of the element. By reason of the diagonally upward direction of the radiation, the opposed surfaces 56a and 57a of adjacent portions of the spiral do not interradiate to any great extent, and inter-radiate much less than if the walls 56a, 57a were not beveled or inclined with respect to the general plane of the element. In general, the amount of downward radiation from the wall 55a is much less than the upward radiation from the walls 56a, 57a. By decreasing the width of the wall 55a with respect to the walls 56a, 57a the downward radiation may be made still less if desired.

It will of course be apparent that what has been hereinbefore stated with respect to reduced inter-radiation between adjacent portions of a spirally formed element applies also to adjacent portions of separate elements and whether the longitudinal axes of the elements are spiral, rectilinear, or of any other form.

The resistor may be constructed and arranged so that it is non-symmetrical with respect to the cross-section of the heating element in any desired cross-sectional form, either in conection with the forms herein illustrated or in connection with any desired form. Figure 14 is an example of such a construction, and shows a cross-section of an element having a metal sheath 59 similar to the sheath shown in Figure 8, a resistor 60 being embedded in insulating material 61 within the sheath. In this instance the resistor 60 is of sinuously formed wire as shown in the plan view of Figure 15 and defines a surface collateral with the
119 inside surface of the wall 62 of the sheath as shown
in Figure 14, the wall 62 corresponding in this instance to the wall 46 of the element of Figure 8. This construction may be utilized if it is desired that the wall 62 be directly heated more than the other walls.

A further example is shown in Figure 16. A heating element is here shown in cross-section, this element comprising a sheath 63 similar to that of the element shown in Figure 8, but including a resistor 64 so constructed and arranged that its principal heating effect will be on the sides 65, 66 of the sheath, less heat being supplied toward or to the side 67. A fragmentary portion of the resistor 64 is shown in perspective in Figure 17. The resistor 64 is here shown as in the form of a wire bent back and forth in zig-zag or serpentine manner, the so-bent wire being further bent as a whole so that it defines a dihedral angle, the defining sides of which are adapted to be disposed adjacent the inside walls of the sides 65, 66 of the sheath, with the apex of the dihedral angle adjacent the intersection of the sides 65, 66. It will be understood that the resistor 64 initially may be of a form different from that shown in Figures 16 and 17 and may assume the form there shown by reason of the side-pressing of the heating element. On the other hand, as far as the feature of unsymmetrical heat-

ing is concerned the sheath initially may have the general cross-sectional shape of the finished heating element in which case the resistor 64 ordinarily will be formed initially to be complementary to the desired surface of the inside of the sheath. Accordingly, it will be understood that the use of an unsymmetrically disposed resistor is not lim-
120 ited to the forms of elements herein shown, nor to the processes of making them herein disclosed.

The construction shown in Figure 14 may if desired be embodied in an element such as shown in Figures 10 and 11 the wall 62 then corresponding to the wall 55. The construction shown in Figure 16 may, if desired, be embodied in an element such as shown in Figures 12 and 13 the walls 65 and 66 then corresponding to the walls 56a and 57a.

In Figure 18 is shown a hot plate, which may be used for cooking purposes or the like, this comprising a metal plate 68 having triangular grooves 69 in which are disposed the active sheath portions 70 of a triangular section heating element or elements, it being understood that the grooves 69 are of any desired axial configuration to accommodate the element or elements. The cross-section of the active portions 70 is substantially complementary to the cross-section of the grooves 69. Press-forging of the element results in the resistor 90 of the element assuming triangular form substantially similar to the sheath 70. A triangular section heating element is exceedingly well adapted for cooperation with a hot plate or the like because of the ease with which triangular grooves, complementary to the heating element, may be formed in the plate 68.

In the particular instance shown in Figure 18 the sheath 70 is of isosceles section having walls 71, 72, 73, the walls 71, 72 making an angle of less than 60° so that of course the angles between these walls respectively and the other wall 73 are each greater than 60°. This construc-
121 tion is of advantage when it is desired that a larger part of the perimeter of the section shall be in contact with a device to be heated.

Figure 19 shows a press platen comprising a metal plate 74 having triangular section grooves 75 in which are disposed the active sheath portions 76 of a triangular section heating element or elements, similarly to the case of the hot plate of Figure 18. An active portion 76 comprises walls 77, 78, 79, the walls 77, 78 being here shown as making an angle greater than 90°, and fitting complementarily in the groove 75, the walls 77, 78 of course making angles of less than 60° respectively with the wall 79. The resistor 91 of the element of course also has a cross-section substantially similar to the sheath 76. The platen includes a metal plate 80 which bears against the wall 79.

Figure 20 shows a section of a heating element having a sheath the walls 81, 82, 83 of which define an equilateral triangle, the apexes 84 of which are slightly rounded. Under some circumstances it may be desirable, irrespective of the form of the triangle, to have the walls 81, 82, 83 of the sheath slightly cambered as shown in Figure 20, that is, the walls bulge outwardly slightly with respect to the interior of the sheath. In this case the resistor 92 of the element will assume the form of an equilateral triangle the sides of which are cambered. It will be understood that if the element has cambered walls they are so formed by reason of the shape of the dies between which the element is press-forged.

It will be evident from the foregoing that the shape of the triangular section may be varied and that for one purpose a given shape will be best adapted and that for
122 another purpose another shape will be best adapted. Furthermore, the shape of the triangular section may result in different typical cross-sectional aspects of the resistor one of which may be better for one purpose and another of which may be better for another purpose. For example, if it is desired that the resistor shall be most nearly centrally located and uniformly spaced from the walls of the sheath, an equilateral triangular form, or a triangular form in which the defining lines define a triangle

all of the angles of which are 60°, are the best forms. These forms also result in the greatest uniformity of density of insulating material. However, in general, the triangular form is superior to other forms because, among other reasons, there is a minimum of displacement of the resistor and of the insulating material; more uniform density of the insulating material; and circumferential tensile stresses in any portion of the sheath which result from other methods of side-pressing, are minimized or entirely eliminated.

Side-pressing in accordance with my invention, has the advantage that the tubular sheath may be cut to specified length, assembled with resistor, insulating material, and terminals, and the processed as hereinbefore set forth, the predetermined length of the element bing unaltered. Furthermore, the elimination of tensile stresses in the sheath avoids any tendency to burst open a tubular sheath, particularly at a welded seam. A seam may be present in a tubular sheath for a heating element designed to operate at very high temperature since it has not been found feasible to manufacture seamless tubing from high
123 temperature alloys such as nickel-chrome. Tubing made from such alloys is rolled from ribbon to tubular form and seam-welded, which of course tends to affect the strength of the metal adjacent the weld.

An element such as shown in Figures 1 and 2, or an element such as shown in Figures 3, 4, and 5 may have discontinuities or voids in the insulating material, or such discontinuities and voids may be produced by bending an element of either of these forms to a non-rectilinear form. These discontinuities and voids are in themselves objectionable, and furthermore, gases in these discontinuities or voids are apt to be ionized, thereby further reducing the insulating value of the insulation, this being particularly true where the elements are designed so that the energy in-put is such that the units operate at a desired external temperature of from 1200° or 1400° F. to 1600° F. or

higher, temperatures at which these elements are capable of operation. Accompanying the reduction in insulating value of the insulation is also a reduction in the life of the elements. This will be true even if the sheath is made of nickel, or a metal alloy, for example, nickel chrome, or "inconel", capable of withstanding such temperatures, and it is of course understood that a sheath made of a material capable of operation at such temperatures may be used. However, the shaping and press-forging of the elements as described, redistributes, recompacts and further densifies the insulating material so as to close up any discontinuities or voids which may be present therein either due to the bending of the elements, or due to any other cause.
124 Thus, the side press-forging of the elements to a more efficient cross-section at the same time increases the life of the elements.

It will be evident that the sheath may be of other desired and suitable initial and intermediate forms before it is brought to triangular cross-section; that the sheath may be of any desired suitable metal or alloy; that the resistor may be of any desired suitable composition, and of any desired suitable form; that the refractory insulating material may be, or may include, for example, silica, or silicates, or magnesium oxide, or aluminum oxide, or any refactory oxide or combination of refractory oxides, or any other suitable refractory material, desirably of a mineral character; that such refractory material may be mixed, if desired, with a bonding or cementing material, or mixed with a clay, or with any other suitable binder; and that the initial form or state of the insulating material, in which it is introduced into or assembled with the sheath, may be varied, and, if necessary, varied to suit the form of the sheath and the method of making it, and to suit any desired method of introducing the insulating material into the sheath or of assembling it with the sheath.

From the foregoing it will be apparent to those skilled in the art that the disclosed embodiments of my invention

provide new and improved electrical heating elements, and
new and improved processes for making the same, and ac-
cordingly, each accomplishes the principal object of my
invention. On the other hand, it also will be obvious to
those skilled in the art that the disclosed embodi-
125 ments of my invention may be variously changed
and modified, or features thereof, singly or collec-
tively, embodied in other combinations than those dis-
closed, without departing from the spirit of my invention,
or sacrificing all of the advantages thereof, and that ac-
cordingly, the disclosure herein is illustrative only, and
my invention is not limited thereto.

126 12. An electrical heating element, comprising: a
metal sheath, having a generally triangular cross-
sectional outline; resistor means disposed within and in-
sulated from said sheath, said resistor means being sub-
stantially continuously distributed approximately in a
plane longitudinally of one side only of said sheath.

13. An electrical heating element, comprising: a metal sheath, having a generally triangular cross-sectional outline; and a resistor disposed within and insulated from said sheath, said resistor being so constructed and arranged that it is generally V-shaped in cross-sectional aspect and is so disposed within said sheath that said V-shape is generally complementary to one of the angles defined by the triangular cross-sectional outline of said sheath.

14. The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a cross-sectional outline comprising a plurality of substantially straight line portions, two of which portions respectively make interior angles of less than ninety degrees relatively to another of said portions.

15. The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said 127 resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

16. The process of making an electrical heating element, which comprises: providing a metal sheath, of circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath to a generally triangular cross-sectional outline.

17. The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to defrom at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different from said oblong outline.

18. The process of making an electrical heating element, which comprises: providing a metal sheath, of circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; 128 applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline.

19. The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal axis of which is rectilinear and the cross-sectional outline of which is circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a cross-sectional outline different from said oblong outline.

20. The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal axis of which is rectilinear and the cross-sectional outline of which is substantially circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional
outline; bending said portion in the minor axial gen-
129 eral plane of said portion so that the longitudinal
axis of said portion is non-rectilinear; and applying
pressure to said bent portion to deform at least a part thereof to a generally triangular cross-sectional outline.

21. The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than

the perimeter of the original cross-sectional outline of said portion.

22. The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying a second die to said sheath and moving said second die toward said first die until said sheath is deformed to a generally triangular cross-sectional outline and the pressure applied by said second die to the part of the surface of the sheath in contact therewith is of the order of 25 tons or more per square inch of said surface.

130 33. An electrical heating element, comprising: a
metallic sheath having wall portions defining a closed
cross-sectional outline comprising a plurality of substan-
tially straight line portions, two of said portions respec-
tively making interior angles of substantially less
131 than ninety degrees relatively to another of said por-
tions; compacted refractory heat-conducting elec-
trical-insulating material disposed within said sheath and
in heat-transfer contact with the inside surface of said
sheath at said wall portions, the cross-sectional outline of
said inside surface and the cross-sectional outline of said
insulating material conforming to each other; and resistor
means embedded in said compacted insulating material and
insulated from said sheath by said insulating material.

34. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions, and said two portions making between them an angle of substantially less than ninety degrees; compacted refractory heat-con-

ducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

132 35. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially sixty degrees relatively to another of said portions; compacted refractory heat-conducting electrical insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

36. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions, and said two portions making between them an angle of at least ninety degrees; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

133 37. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

38. An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heating-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

39. An electrical heating element, comprising: a metallic sheath having portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane; compacted refractory heat-conducting electrical-insulating material disposed
134 within said sheath and in heat-transfer contact with
the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral end portion bent so as to extend at an angle to said plane.

40. An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of said axis; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

41. An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of the axis; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral portion bent so as to extend at an angle to said planes.

42. An electrical heating element, comprising: a metallic sheath; resistor means within and insulated from said sheath, said resistor means being substantially continuously distributed longitudinally of a portion of said sheath, said resistor means defining a surface unsymmetrical with

respect to the cross-sectional outline of the inside surface of said sheath so that the sheath portion nearest said resistor means is directly heated to a substantially greater extent than the remainder of said sheath, said surface defined by said resistor means being circumferentially discontinuous in cross-sectional aspect, extending circumferentially along a part only of the cross-sectional outline of said inside surface.

43. An electrical heating element, comprising: a metallic sheath; resistor means within and insulated from said sheath, said resistor means being substantially con-
136 tinuously distributed longitudinally of a portion of
said sheath, said resistor means defining a surface unsymmetrical with respect to the cross-sectional outline of the inside surface of said sheath so that the sheath portion nearest said resistor means is directly heated to a substantially greater extent than the remainder of said sheath, said surface defined by said resistor means being approximately uniformly spaced from said inside surface longitudinally and circumferentially and extending circumferentially along a part only of the cross-sectional outline of said inside surface.

44. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and ex-

tending collaterally with respect to the inside surface of at least one of said wall portions.

137 45. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of at least one of said wall portions.

46. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of asid insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of only one of said wall portions.

138 In testimony whereof I hereunto affix my signature.

EDWIN L. WIEGAND

Oath

I, Edwin L. Wiegand, the above named petitioner, being first duly sworn, on oath depose and say: I am a citizen of the United States, and a resident of Pittsburgh, Allegheny County, Pennsylvania; I verily believe myself to be the original, first, and sole inventor of the Electrical Heating Elements described and claimed in the annexed specification; I do not know and do not believe that the same was ever known or used before my invention or discovery thereof, or patented or described in any printed publication in any country before my invention or discovery thereof, or more than one year prior to this application, or patented in any country foreign to the United States on an application filed more than twelve months prior to this application, or in public use or on sale in the United States for more than one year prior to this application; and no application for patent on said invention has been filed by me or by my representatives or assigns in any country foreign to the United States.

EDWIN L. WIEGAND

Sworn to and subscribed before me, a Notary Public in and for the County of Allegheny, Commonwealth of Pennsylvania, within said County, this 18th day of October, 1940.

J. C. HENNESSY,
Notary Public

My commission expires March 19, 1943.

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361997 #2

Print of drawing as originally filed /

FIG. 1

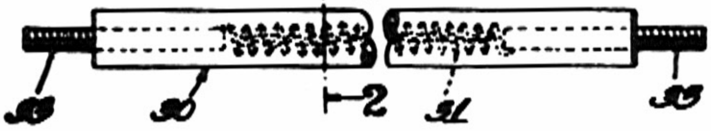


FIG. 2

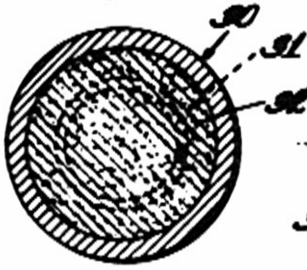


FIG. 5

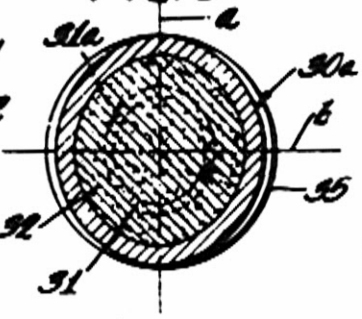


FIG. 3

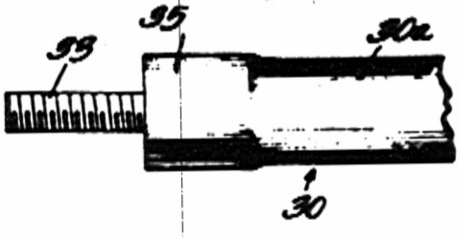


FIG. 4

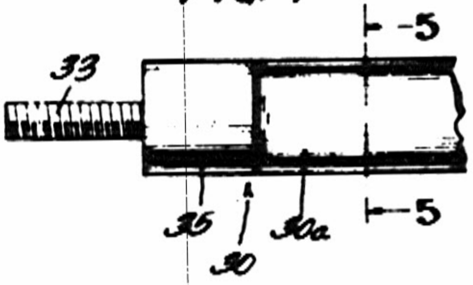


FIG. 6

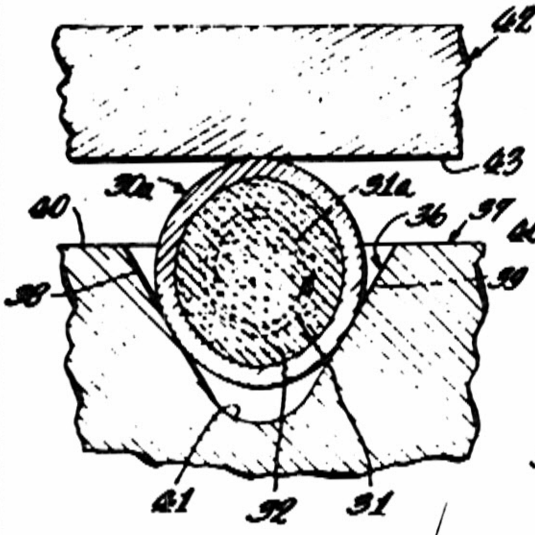


FIG. 7

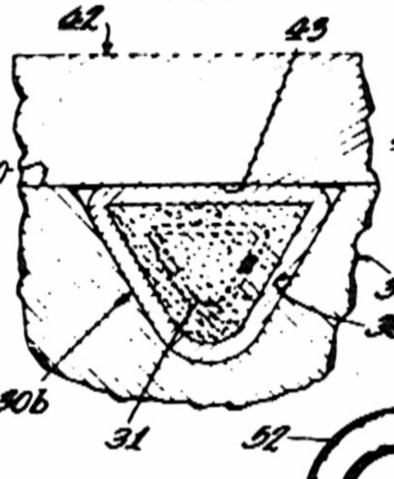


FIG. 8

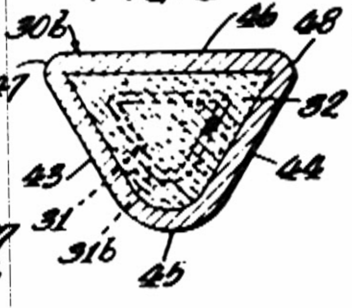


FIG. 9

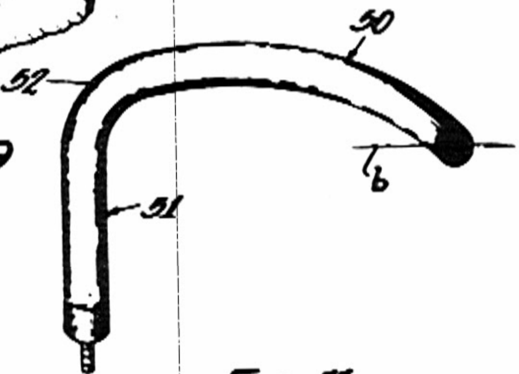


FIG. 10

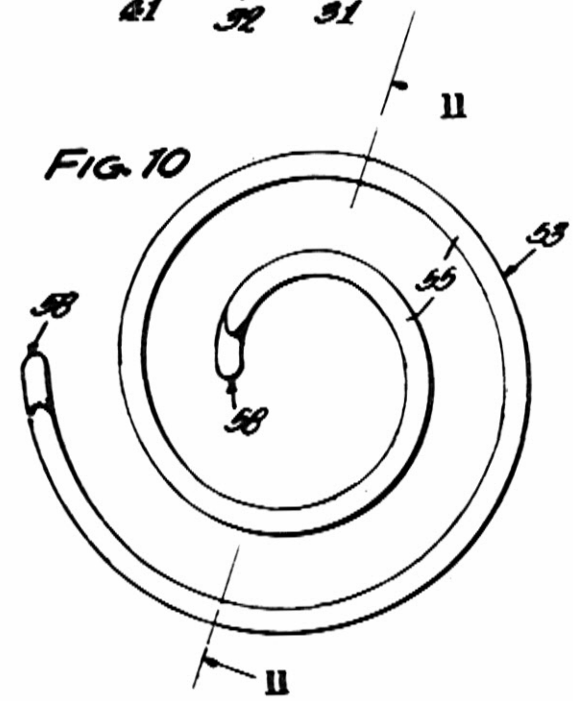
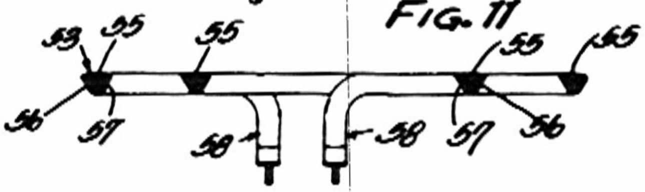


FIG. 11



EDWIN L. WIEGAND
INVENTOR

BY Freeman, Sweet and Albrecht
ATTORNEYS

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361997

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FIG. 12

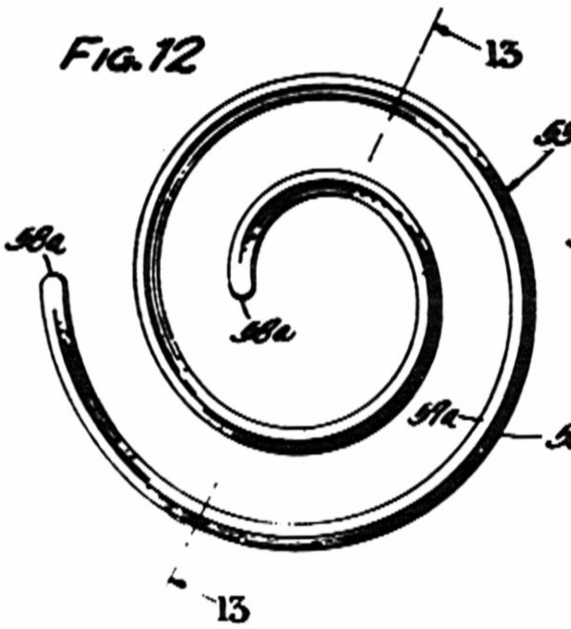
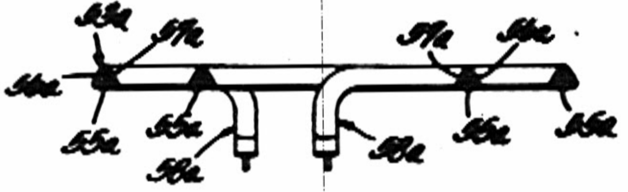


FIG. 13



[illegible]

FIG. 14

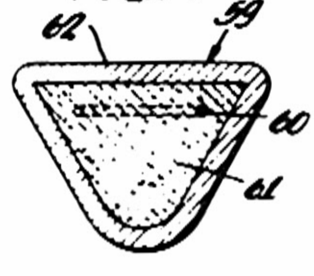


FIG. 15

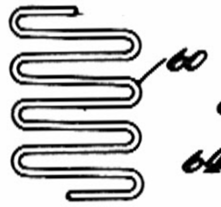


FIG. 16

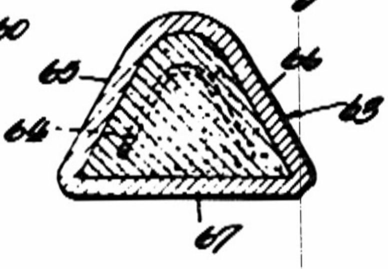


FIG. 17

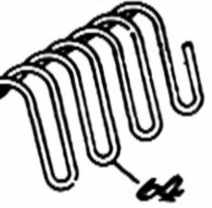


FIG. 18

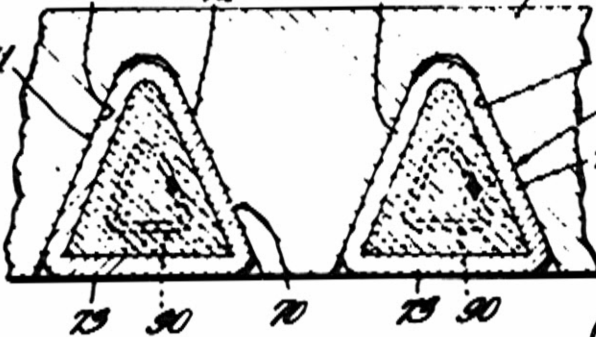


FIG. 19

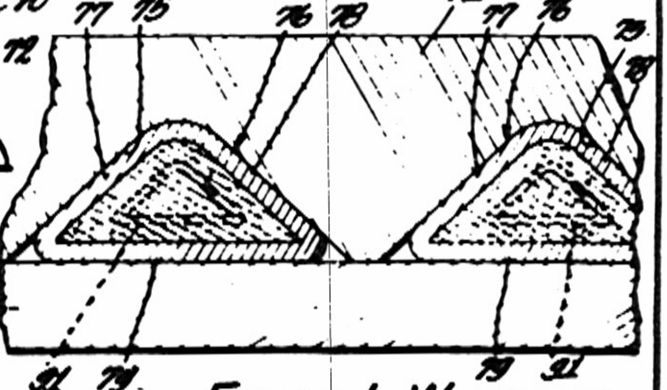
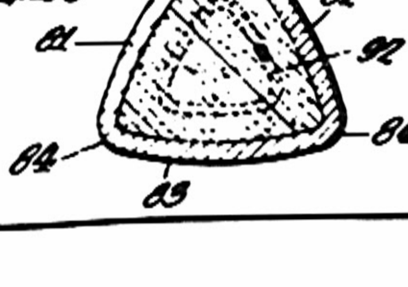


FIG. 20



EDWIN L. WIEGAND
INVENTOR

BY Freeman, Sweet and Albrecht
ATTORNEYS

Plaintiff's Exhibit No. 2.

142 Filed Apr 25 1941

To the Commissioner of Patents:

Your petitioner, Edwin L. Wiegand, a citizen of the United States and a resident of Pittsburgh, Allegheny County, Pennsylvania, whose post office address is 7500 Thomas Boulevard, Pittsburgh, Pennsylvania, prays that Letters Patent may be granted to him for the invention in Electrical Heating Elements set forth in the annexed specification; and he hereby appoints as his attorneys Hadley F. Freeman, Donald H. Sweet, and George M. Albrecht, constituting the firm of Freeman Sweet and Albrecht, Hanna Building, Cleveland, Ohio, and each of them, each and all with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent Office connected therewith.

Signed at Pittsburgh, Allegheny County, Pennsylvania, this 21st day of April, 1941.

EDWIN L. WIEGAND

Specification

To All Whom It May Concern:

Be it known that I, Edwin L. Wiegand, a citizen of the United States, and a resident of Pittsburgh, Allegheny County, Pennsylvania, have invented certain new and useful Electrical Heating Elements of which the following is a full, clear, and exact description.

143 My invention relates to electrical resistance heating units or elements of various types comprising a resistor disposed within and insulated from a metal sheath. The principal object of my invention is to provide new and improved processes of making heating elements or units of these types. This application is a division of my application Serial Number 361,997, filed October 21, 1940.

In the drawings accompanying this specification, and forming a part of this application, I have shown, for purposes of illustration, several forms which my invention may assume, and in these drawings:

Figure 1 is a fragmentary side view of an electrical heating element in an intermediate stage of a process of making an element in accordance with my invention.

Figure 2 is an enlarged cross-sectional view taken on the line 2-2 of Figure 1,

Figure 3 is an enlarged fragmentary view of a side of an element in a later stage of a process of making an element in accordance with my invention,

Figure 4 is an enlarged fragmentary side view of an element in the stage shown in Figure 3, but looking in a direction at right angles to the direction in which the element is viewed in Figure 3,

Figure 5 is an enlarged cross-sectional view taken on the line 5-5 of Figure 4, looking in the direction of the arrows,

Figure 6 is a cross-sectional view showing dies ready to press-forge an element to its final cross-sectional form, the element in this instance having a cross-sectional form such as shown in Figure 5,

144 Figure 7 is a cross-sectional view showing the dies and element after the dies have been brought together,

Figure 8 is a cross-sectional view of an electrical heating element embodying my invention,

Figure 9 is a fragmentary perspective view of an electrical heating element in an intermediate stage of a process of making another embodiment of an element in accordance with my invention,

Figure 10 is a plan view of another element embodying my invention,

Figure 11 is a section taken on the line 11-11 of Figure 10,

Figure 12 is a plan view of another element embodying my invention, Figure 13 is a section taken along the line 13-13 of Figure 12,

Figure 14 is a cross-sectional view of another element embodying my invention,

Figure 15 is a fragmentary plan view of the resistor of the element shown in Figure 14,

Figure 16 is a cross-sectional view of another element embodying my invention,

Figure 17 is a fragmentary perspective view of the resistor of the element shown in Figure 16,

Figure 18 is a cross-sectional view of a hot plate showing associated therewith another element or elements embodying my invention,

Figure 19 is a cross-sectional view of a press platen or the like showing associated therewith another element or elements embodying my invention, and

Figure 20 is a cross-sectional view of another element embodying my invention.

The element shown in Figures 1 and 2 comprises a rectilinear tubular metal sheath 30 of circular cross-sectional outline, within which is disposed a resistor 31 of desired form, in this instance a helix of resistance wire. The resistor 31 is embedded in refractory electrical-insulating heat-conducting material and desirably uniformly spaced from the inside wall of the sheath 30. Projecting from the ends of the sheath 30 and extending into the insulating material 32 within the sheath a desired distance are terminals 33, these being suitably connected to the ends of the resistor 31. One way in which a metal-sheathed insulated resistor such as shown in Figures 1 and 2 may be produced is to dispose a resistor in a tubular metal sheath so that the resistor is spaced from the inside walls of the sheath, and then introduce refractory insulting material in a granular, or comminuted, or powdered state into the sheath, the insulating material being compacted to any desired degree and in any desired manner. However, my invention is not limited to any particular way or producing such a metal-sheathed insulated resistor. The sheath may be made in any desired and suitable way and assembled with the resistor and insulating material in any desired and suitable manner and in any desired sequence, and the insulating material may be compacted in any desired and suitable manner.

While I prefer not to compact the insualting material 32 by swaging the sheath 30 to a smaller circular outline because this operation draws and elongates the sheath and has other objections, as will appear, my invention is also applicable in case a metal-sheathed resistor such as shown in Figures 1 and 2 has involved swaging and elongation of the sheath. I prefer to use any method of prelim-
146 inarily compacting the insulating material which will
not elongate the sheath. I then prefer next to side-press the sheath 30 so that its cross-sectional outline is generally elliptical or oval, or, in general, of oblong form. This step is particularly desirable if in its final form the element is to have a non-rectilinear longitudinal axis, but is also useful and desirable even if the element is to remain rectilinear, as will appear. The element shown in Figures 1 and 2 is placed between dies (not shown) having similar matrix portions which when brought together will produce the desired oblong cross-sectional outline. When the element is so side-pressed it may assume an ablong cross-sectional form 30a such as shown in Figure 5, the resistor also assuming a corresponding oblong cross-sectional aspect as shown at 31a. When the element is viewed from the side and in the plane of the major axis *a* of the cross-section 30a it appears as in Figure 3, and when viewed in the plane of the minor axis *b* of the cross-section 30a, it appears as in Figure 4. It will be understood that when the element is in the form shown in Figures 3, 4 and 5, the longitudinal axis thereof still is rectilinear, and as shown in these Figures, the sheath is not side-pressed to an oblong cross-sectional outline throughout its entire length but an end portion 35 at each end may be left of circular cross-

section. The portion 30a of oblong cross-sectional outline desirably overlaps a portion of that part of a terminal 33 which is disposed within the sheath 30. The side-pressing operation just described serves to compact the insulating material 32 to a sufficient degree, if it is not already so compacted, to maintain the resistor 31 in a central position within the sheath 30 when the element is subsequently bent to non-rectilinear form or when it is otherwise worked, or both.

147 I prefer that the oval or oblong cross-section 30a have a major axis approximately the same as, or at least not materially greater than, the diameter of the original circular section of the sheath. Dies which bring the sheath to such oval form will of course confine the sheath against free elongation in the direction of the major axis, the oval or oblong shape being secured instead by reduction of the diameter of the sheath in the direction of the minor axis.

Whether or not the element shown in Figures 3, 4, and 5 is bent to non-rectilinear form, that portion thereof which is of oblong cross-sectional outline 30a, or a desired longitudinal part thereof, is placed in the matrix 36 of a die 37 as shown in Figure 6. The matrix 36 is of generally V-shape cross-section having straight sides 38, 39 making between them an angle of 60°, the bisecting line of the angle being normal to the upper flat face 40 of the die. The apex of the triangle formed by the sides 38, 39 is here shown as rounded off by a fillet 41. The element preferably is so placed in the matrix 36 that the major axis of the oblong cross-sectional outline 30a coincides approximately with the line bisecting the angle between the lines 38, 39. Another die 42 having a flat operating face 43 is then brought down against the element until the dies 37, 42 contact as in Figure 7, thereby press-forging the element so that its cross-sectional outline 30b is generally triangular. Thus, the sheath now has two walls 43, 44, (Figure 8), the major portions of which are flat and make between them an angle

of 60°, these walls merging in a rounded apex 45 formed by the fillet 41 of the matrix 36. The third wall 46 is
148 substantially entirely flat and makes with the walls 43, 44 angles of 60° respectively. Thus in this particular element the flat portions of the walls 43, 44 are respectively of less cross-sectional extent than the substantially entirely flat wall 46. This is of advantage under some circumstances of use and is the reason the fillet 45 is provided. The radius of the fillet may be as desired, or the matrix may be V-shaped with no fillet at the apex.

The cross-sectional perimeter of the cavity formed by the matrix portion 36 of the die 37 and the face 43 of the die 42 when the faces 40 and 43 of these dies are in contact as in Figure 7, is preferably such that the perimeter of the generally triangular cross-sectional outline 30b of the element is less than the cross-sectional perimeter of the original circular section sheath 30. However, even if the perimeter of the final cross-section shown in Figure 8 is substantially the same as the perimeter of the original sheath, the press-forging of the element to a generally triangular cross-sectional outline results in a very large reduction in cross-sectional area and hence in compaction of the insulating material 32 to very great density. The corners 47, 48 of the cross-section are slightly rounded, the amount of this rounding depending on the relation between the original section of the element and the cavity between the matrix 36 of the die 37 and the face 43 of the die 42.

By pressing the element to generally triangular cross-sectional outline the resistor 31 is reformed so that its cross-sectional aspect 31b is generally triangular as shown in Figure 8, the outline of the resistor being substantially similar to and substantially uniformly spaced from
149 the outline of the inner wall of the sheath, and more nearly so if, as in this instance, the sides of the sheath define a triangle the adjacent sides of which are at 60° to each other. In general, however, in an element triangularly pressed, even if the angles are not all 60°, there

is a minimum of undesirable flowing or displacement of the insulating material so that there is a minimum of displacement of the resistor from a symmetrical and uniform position with respect to the walls of the sheath. In the finally pressed element, as shown in Figure 8, the resistor is uniformly spaced from the flat walls 43, 44, 46 but is closer to these walls than it is to the inner wall of the sheath when the sheath is of either the original circular or oblong cross-sectional outlines as in Figures 2 and 5 respectively.

The pressures which I prefer to use to press the element to triangular cross-section outline are so high that the element is to be regarded as not merely deformed or pressed to generally triangular cross-section but as press-forged. I prefer to use pressures of 25 tons per square inch or more. For example, I use a press capable of exerting a pressure such that when the die 42 reaches the end of its stroke the pressure on the surface of the wall 46 of the element is approximately 40 tons per square inch, or more. These pressures are so high that the material is "upset". This is evidenced, for example, by the fact that the resistor 31 is upset and shortened, that is, in effect forged. For instance in the case of a resistor in an initially circular section tubular sheath about 5/16 of an inch to 11/32 of an inch in outside diameter and having a wall thickness of .030 of an inch, the resistor is upset and shortened to such an extent that its electrical resistance is decreased approximately 8 to 10%, when the element has been subjected to approximately 40 tons per square inch as hereinbefore described. The amount of upsetting and decrease will of course depend upon the pressure used and I give the foregoing as an illustration that a press-forging action does take place, and not by way of limitation to particular dimensions or other values.

For any given density or compaction of the insulating material, a triangular section element will contain less insulating material, and hence the sheath will become heated more quickly. Also, for a given initial amount of insulating material, the insulating material in an element embodying my invention is compacted to a super-density, thereby further improving its heat conducting properties. In general, a triangular section element provides the optimum combination of rigidity and strength with a greater ratio of sheath area to element volume and weight. Or stated in another way, it provides a greater ratio of perimeter to sectional area and what is more important, a much larger percentage of perimeter and sheath area may be brought into contact with an object to be heated, and the path of conduction from the opposite extreme point on the sheath is considerably reduced from what it is in, for example, a round section merely pressed somewhat flat on one or both sides. For any one or more of these reasons, heat is more quickly conducted from the resistor to the sheath.

Furthermore, I have made comparative tests on tubular heating elements of circular section and tubular heating elements of triangular section made in accordance with my invention from tubular sheath the same size as the circular section elements and have found that the watts input
151 per square inch of external active surface of the heating element required to fuse the resistor is approximately 15 to 25% higher in the case of the triangular section elements than it is in the case of the circular section elements. Referring to an element of the size hereinbefore mentioned, the resistor fusing point is raised to about 225 watts per square inch of active resistor area. This is because the temperature gradient from the very center of the element section to the outer surface of the sheath is considerably reduced over other constructions. Obviously this feature permits material increase in the maximum normal operating capacity or temperature or both. By way of example, an element of the size hereinbefore mentioned may be normally operated at about 50 to 60 watts per square inch of active surface, in open air at room temperature. By active surface of the sheath I mean the surface of the

sheath surrounding and longitudinally coextensive with the resistor.

I prefer first to side-press the element to an oval or oblong cross-section before placing it in the die 37, even if the longitudinal axis of the finished element is to be rectilinear, but I may also place an element of circular section in the die 37 and press-force it to triangular cross-section.

An element in accordance with my invention may be made of non-rectilinear form in whcih case I prefer first to provide an element of rectilinear form as shown in Figures 1 and 2, then to side-press it to an oblong cross-sectional outline as shown in Figures 3, 4, and 5 and then to bend an
active portion 50 thereof as shown in Figure 9. In
152 bending the active portion 50 I prefer to bend it in
the plane defined by the minor axis *b* of the oblong
section. If desired an end portion 51, or both end portions, of the element may be bent out of the plane defined by the bent active portion 50, this end portion 51 being joined to the active portion 50 by a bent portion 52 bent in the plane of the major axis of the oblong section, or the terminal zone between the active portion and the extremity of the element may be further pressed round before bending or to any other desirable shape for optimum bending conditions and to secure maximum compactness at this zone. The active portion 50 may be bent in the form of a spiral, or in any other desired form. In any case the bent active portion 50 is placed in a die having a triangular matrix portion, similar to the matrix portion 36, this matrix portion of course having a longitudinal axis corresponding to the longitudinal axis of the bent active portion 50. The active portion 50 is then press-forged to triangular section as hereinbefore described.

An element in accordance with my invention is extremely rigid, though it be long, or have a non-rectilinear longitudinal axis, or both.

Figures 10 and 11 show an element embodying my invention, which has an active portion 53 of spiral form and

of triangular cross-section, having wall portions 55, 56, 57,
the wall portion 55 defining a plane corresponding to the
general plane of the spiral. The element has end
153 portions 58, similar to the end portion 51 of Figure
9, which extend transversely of the plane of the
spiral and, in this instance, are disposed at that side of the
element opposite from the plane of the wall 55.

Figures 12 and 13 show an element embodying my invention, which is similar to the element shown in Figures 10 and 11 except that the element of Figures 12 and 13 has end portions 58a which, while they extend transversely of the general plane of the spiral active portion 53a of the element, are disposed at the same side of the element as the plane defined by the wall 55a corresponding to the wall 55 of the element of Figures 10 and 11.

One use for heating elements such as shown in Figures 10 through 13 is in electric ranges but their use is not limited to that purpose.

It will be noted that if an object to be heated and having
a generally plane surface is placed against the wall 55 of
the element shown in Figures 10 and 11, there will be a
comparatively large area of contact between the object and
the element so that under these conditions the object is
heated largely by conduction. On the other hand, if such
an object is placed against the upper defining surface, as
viewed in Figure 13, of the element shown in Figures 12
and 13, the object will be in contact with the apexes of the
triangular sections and will be heated mainly by radiation
from the walls 56a and 57a of the element. It will be noted
that due to the triangular section of the element the
154 bulk of the radiation from the element is directed up-
wardly. The bulk of the radiation from the walls
56a, 57a is directed diagonally upwardly in respectively op-
posite directions considering any given portion of the ele-
ment. By reason of the diagonally upward direction of the
radiation, the opposed surfaces 56a and 57a of adjacent
portions of the spiral do not interradiate to any great ex-

tent, and inter-radiate much less than if the walls 56a, 57a were not beveled or inclined with respect to the general plane of the element. In general, the amount of downward radiation from the wall 55a is much less than the upward radiation from the walls 56a, 57a. By decreasing the width of the wall 55a with respect to the walls 56a, 57a the downward radiation may be made still less if desired.

It will of course be apparent that what has been hereinbefore stated with respect to reduced inter-radiation between adjacent portions of a spirally formed element applies also to adjacent portions of separate elements and whether the longitudinal axes of the elements are spiral, rectilinear, or of any other form.

The resistor may be constructed and arranged so that it is non-symmetrical with respect to the cross-section of the heating element in any desired cross-sectional form, either in connection with the forms herein illustrated or in connection with any desired form. Figure 14 is an example of such a construction, and shows a cross-section of an element having a metal sheath 59 similar to the sheath shown in Figure 8, a resistor 60 being embedded in insulating material 61 within the sheath. In this instance the resistor 60 is of sinuously formed wire as shown in the plan view of Figure 15 and defines a surface collateral with the inside surface of the wall 62 of the sheath as shown in Figure 14, the wall 62 corresponding in this instance to the wall 46 of the element of Figure 8. This construction may be utilized if it is desired that the wall 62 be directly heated more than the other walls.

A further example is shown in Figure 16. A heating element is here shown in cross-section, this element comprising a sheath 63 similar to that of the element shown in Figure 8, but including a resistor 64 so constructed and arranged that its principal heating effect will be on the sides 65, 66 of the sheath, less heat being supplied toward or to the side 67. A fragmentary portion of the resistor 64 is shown in perspective in Figure 17. The resistor 64 is here

shown as in the form of a wire bent back and forth in zigzag or serpentine manner, the so-bent wire being further bent as a whole so that it defines a dihedral angle, the defining sides of which are adapted to be disposed adjacent the inside walls of the sides 65, 66 of the sheath, with the apex of the dihedral angle adjacent the intersection of the sides 65, 66. It will be understood that the resistor 64 initially may be of a form different from that shown in Figures 16 and 17 and may assume the form there shown by reason of the side-pressing of the heating element. On the other hand, as far as the feature of unsymmetrical heating is concerned the sheath initially may have the general cross-sectional shape of the finished heating element in which case the resistor 64 ordinarily will be formed initially to be complementary to the desired surface of the inside of
the sheath. Accordingly, it will be understood that
156 the use of an unsymmetrically disposed resistor is
not limited to the forms of elements herein shown,
nor to the processes of making them herein disclosed.

The construction shown in Figure 14 may if desired be embodied in an element such as shown in Figures 10 and 11 the wall 62 then corresponding to the wall 55. The construction shown in Figure 16 may, if desired, be embodied in an element such as shown in Figures 12 and 13 the walls 65 and 66 then corresponding to the walls 56a and 57a.

In Figure 18 is shown a hot plate, which may be used for cooking purposes or the like, this comprising a metal plate 68 having triangular grooves 69 in which are disposed the active sheath portions 70 of a triangular section heating element or elements, it being understood that the grooves 69 are of any desired axial configuration to accommodate the element or elements. The cross-section of the active portions 70 is substantially complementary to the cross-section of the grooves 69. Press forging of the element results in the resistor 90 of the element assuming triangular form substantially similar to the sheath 70. A triangular section heating element is exceedingly well adapted for cooperation with a hot plate or the like because of the ease with which triangular grooves, complementary to the heating elment, may be formed in the plate 68.

In the particular instance shown in Figure 18 the sheath 70 is of isosceles section having walls 71, 72, 73, the walls 71, 72 making an angle of less than 60° so that of course the angles between these walls respectively and the other wall
73 are each greater than 60°. This construction is
157 of advantage when it is desired that a larger part of
the perimeter of the section shall be in contact with
a device to be heated.

Figure 19 shows a press platen comprising a metal plate 74 having triangular section grooves 75 in which are disposed the active sheath portions 76 of a triangular section heating element or elements, similarly to the case of the hot plate of Figure 18. An active portion 76 comprises walls 77, 78, 79, the walls 77, 78 being here shown as making an angle greater than 90°, and fitting complementarily in the groove 75, the walls 77, 78 of course making angles of less than 60° respectively with the wall 79. The resistor 91 of the element of course also has a cross-section substantially similar to the sheath 76. The platen includes a metal plate 80 which bears against the wall 79.

Figure 20 shows a section of a heating element having a sheath the walls 81, 82, 83 of which define an equilateral triangle, the apexes 84 of which are slightly rounded. Under some circumstances it may be desirable, irrespective of the form of the triangle, to have the walls 81, 82, 83 of the sheath slightly cambered as shown in Figure 20, that is, the walls bulge outwardly slightly with respect to the interior of the sheath. In this case the resistor 92 of the element will assume the form of an equilateral triangle the sides of which are cambered. It will be undertsood that if the element has cambered walls they are so formed by reason of the shape of the dies between which the element is press-forged.

It will be evident from the foregoing that the shape of the triangular section may be varied and that for one purpose a given shape will be best adapted and that for
158 another purpose another shape will be best adapted.

Furthermore, the shape of the triangular section may result in different typical cross-sectional aspects of the resistor one of which may be better for one purpose and another of which may be better for another purpose. For example, if it is desired that the resistor shall be most nearly centrally located and uniformly spaced from the walls of the sheath, an equilateral triangular form, or a triangular form in which the defining lines define a triangle all of the angles of which are 60°, are the best forms. These forms also result in the greatest uniformity of density of insulating material. However, in general, the triangular form is superior to other forms because, among other reasons, there is a minimum of displacement of the resistor and of the insulating material; more uniform density of the insulating material; and circumferential tensile stresses in any portion of the sheath which result from other methods of side-pressing, are minimized or entirely eliminated.

Side-pressing in accordance with my invention, has the advantage that the tubular sheath may be cut to specified length, assembled with resistor, insulating material, and terminals, and then processed as hereinbefore set forth, the predetermined length of the element being unaltered. Furthermore, the elimination of tensile stresses in the sheath avoids any tendency to burst open a tubular sheath, particularly a welded seam. A seam may be present in a tubular sheath for a heating element designed to operate at very high temperature since it has not been found feasible to manufacture seamless tubing from high
159 temperature alloys such as nickel-chrome. Tubing
made from such alloys is rolled from ribbon to tubular form and seam-welded, which of course tends to affect the strength of the metal adjacent the weld.

An element such as shown in Figures 1 and 2, or an element such as shown in Figures 3, 4, and 5 may have discontinuities or voids in the insulating material, or such discontinuities and voids may be produced by bending an element of either of these forms to a non-rectilinear form. These discontinuities and voids are in themselves objectionable, and furthermore, gases in these discontinuities or voids are apt to be ionized, thereby further reducing the insulating value of the insulation, this being particularly true where the elements are designed so that the energy in-put is such that the units operate at a desired external temperature of from 1200° or 1400° F. to 1600° F. or higher, temperatures at which these elements are capable of operation. Accompanying the reduction in insulating value of the insulation is also a reduction in the life of the elements. This will be true even if the sheath is made of nickel, or a metal alloy, for example, nickel chrome, or "inconel", capable of withstanding such temperatures, and it is of course understood that a sheath made of a material capable of operation at such temperatures may be used. However, the shaping and press-forging of the elements as described, redistributes, recompacts and further densifies the insulating material so as to close up any discontinuities or voids which may be present therein either due to the bending of the elements, or due to any other cause. Thus, the side press-forging of the elements to a more efficient cross-section at the same time increases the life of the elements.

It will be evident that the sheath may be of other desired and suitable initial and intermediate forms before it is brought to triangular cross-section; that the sheath may be of any desired suitable metal or alloy; that the resistor may be of any desired suitable composition, and of any desired suitable form; that the refractory insulating material may be, or may include, for example, silica, or silicates, or magnesium oxide, or aluminum oxide, or any refractory oxide or combination of refractory oxides, or any other suitable refractory material, desirably of a mineral character; that such refractory material may be mixed, if desired, with a bonding or cementing material, or mixed with a clay, or with any other suitable binder; and that the initial form or state of the insulating material, in which it is introduced into or assembled with the sheath, may be varied, and, if necessary, varied to suit the form of the sheath and the method of making it, and to suit any desired method of introducing the insulating material into the sheath or of assembling it with the sheath.

From the foregoing it will be apparent to those skilled in the art that the disclosed embodiments of my invention provide new and improved processes for making electrical heating elements, and accordingly, each accomplishes the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the disclosed embodiments of my invention may be variously
changed and modified, or features thereof, singly
161 or collectively, embodied in other combinations than
those disclosed, without departing from the spirit
of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

162 I claim:

2. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

3. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular

cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath to a generally triangular cross-sectional outline.

4. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its
original cross-sectional outline to an oblong cross-
163 sectional outline; and applying pressure to said so
deformed portion to deform at least a part thereof
to a cross-sectional outline different in shape from said oblong outline.

5. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline.

6. The process of making an electrical heating element, which comprises; providing a metal sheath the longitudinal axis of which is rectilinear and having a circumferentially continuous wall the cross-sectional outline of which is sub-

stantially circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

7. The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal axis of which is rectilinear and having a circumferentially
164 continuous wall the cross-sectional outline of
which is substantially circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a generally triangular cross-sectional outline.

165 10. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than the perimeter of the original cross-

sectional outline of said portion while the length of said portion is unaltered.

12. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying to said sheath-portion a second die having a surface cooperable with said matrix to deform said sheath-portion to a generally triangular cross-sectional outline, and moving said dies toward each other until said sheath-portion is deformed to a generally triangular cross-sectional outline and the pressure between said second die and the part of the surface of the sheath-portion in contact therewith is of the order of 25 tons or more per square inch of said surface.

13. The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal
axis of which is rectilinear and having a circum-
166 ferentially continuous wall the cross-sectional out-
line of which is circular, said sheath having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a plural-sided cross-sectional outline different from said oblong outline, said last-named pressure being so applied

that an end of said oblong outline is converted to an apex portion of said plural-sided outline.

167 16. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline, said last-named pressure being so applied that a line defining the position of the major axis of said oblong cross-sectional outline becomes the line substantially defining the position of an altitude of said generally triangular cross-sectional outline.

17. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that
168 of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline, said last-named pressure being so applied that a line defining the position of the major axis of said oblong cross-sectional outline becomes the line substantially defining the

position of an altitude of said generally triangular cross-sectional outline.

18. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline the major axis of which is substantially equal in length to the diameter of said circular cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

169 19. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline the major axis of which is substantially equal in length to the diameter of said circular cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline, said last-named pressure being so applied that a line defining the position of the major axis of said oblong cross-sectional outline becomes the line substantially defining the position of an altitude of said generally triangular cross-sectional outline.

20. The process of making an electrical heating element, which comprises: providing a metal sheath having a cir-

cumferentially continuous wall and having a resistor em-
bedded in refractory electrical insulating material disposed
within and having a cross-sectional area corresponding to
that of the inside of said sheath and insulating said resistor
from said sheath; disposing at least an active portion of
said sheath in the matrix of a first die, said matrix
170 being of generally V-shaped cross-section; applying
to said sheath portion a second die having a surface
cooperable with said matrix to deform said sheath-portion
to a generally triangular cross-sectional outline, the cross-
sectional perimeter of the cavity left when said dies are
brought together being such that when said dies are brought
together the cross-sectional perimeter of said generally tri-
angular cross-sectional outline is less than the perimeter
of the original cross-sectional outline of said sheath; and
moving said dies toward each other until said sheath-por-
tion is deformed to said generally triangular cross-sec-
tional outline.

171 In the United States Patent Office

Division 60, Room 5896.

In the Application of: Edwin L. Wiegand, Serial Number 390,371, Filed April 25, 1941, For Electrical Heating Elements.

New Oath

I, Edwin L. Wiegand, being first duly sworn, on oath depose and say: I am a citizen of the United States, and a resident of Pittsburgh, Allegheny County, Pennsylvania; I am the Edwin L. Wiegand the applicant in the above identified application for letters patent; I verily believe myself to be the original, first, and sole inventor of the invention in Electrical Heating Elements described and claimed in said identified application; I do not know and do not believe that the same was ever known or used before my invention or discovery thereof, or patented or described in any printed publication in any country before my invention or discovery thereof, or more than one year prior to my United States application, filed October 21, 1940, serial number 361,997, or patented in any country foreign to the United States on an application filed more than twelve months prior to said application serial number 361,997, or in public use or on sale in the United States for more than one year prior to said application serial number 361,997; and no application for patent on said invention has been filed by me or by my representatives or assigns in any country foreign to the United States, except an application for Canadian patent, filed November 7, 1938, serial number 457,540, based on and corresponding to my United States application filed October 25, 1938, serial number 236,847, and an application for Canadian patent, filed March 22, 1941, serial number 481,273, based on and corresponding to my United States application filed October 21, 1940, serial number 361,997 a continuation in part of my aforesaid United States application serial number 236,847.

EDWIN L. WIEGAND

Sworn to and subscribed before me, a Notary Public in and for the County of Dade, State of Florida, within said County, this 29th day of November, 1941.

LOANNA EDWARDS

(Seal) *Notary Public, State of Florida at Large.*

My Commission Expires Sept. 21, 1945.

237/61

1

C. FIG.
CLASS SUB. CLASS

243/2

FIG. 1

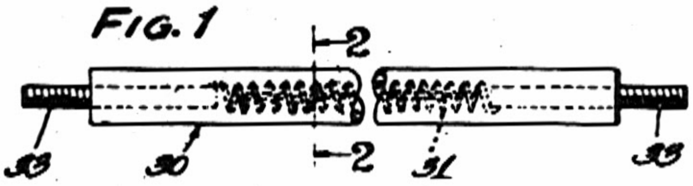


FIG. 3

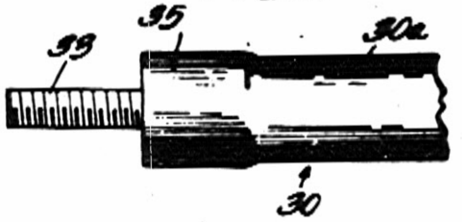


FIG. 2

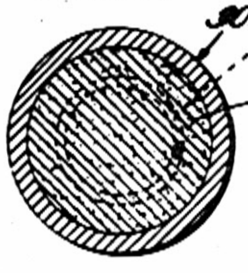


FIG. 5

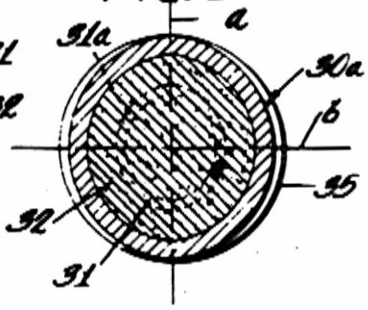


FIG. 4

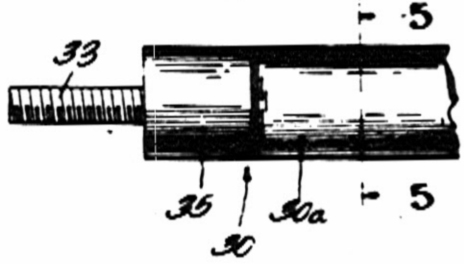


FIG. 6

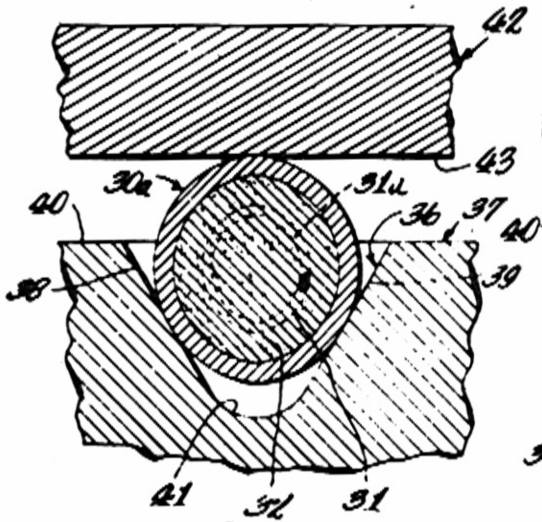


FIG. 7

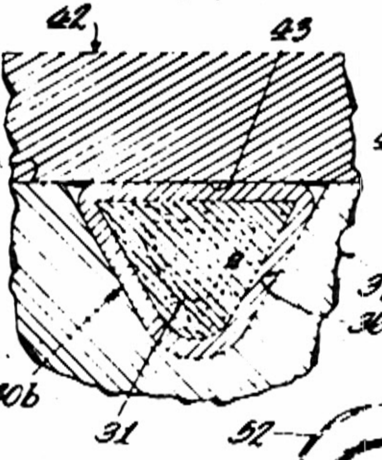


FIG. 8

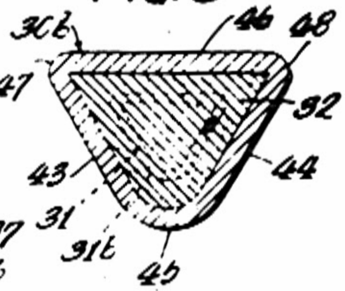


FIG. 9

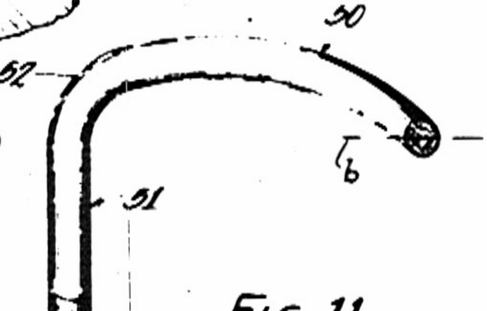


FIG. 10

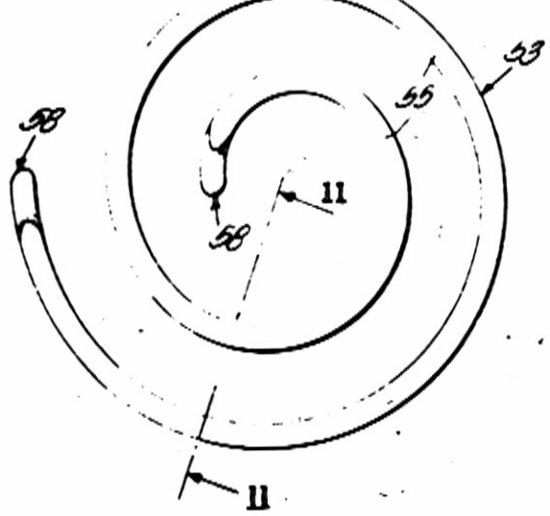
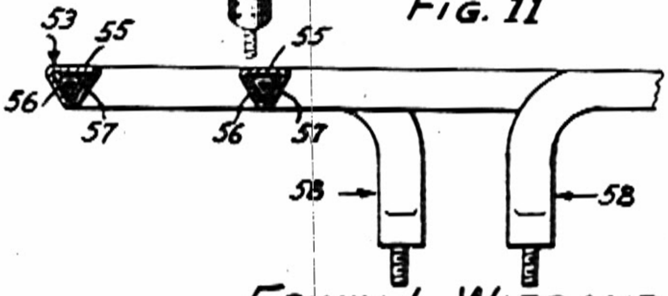


FIG. 11



EDWIN L. WIEGAND
INVENTOR

BY Freeman Sweet and Albrecht
ATTORNEYS

94 a

FIG. 12

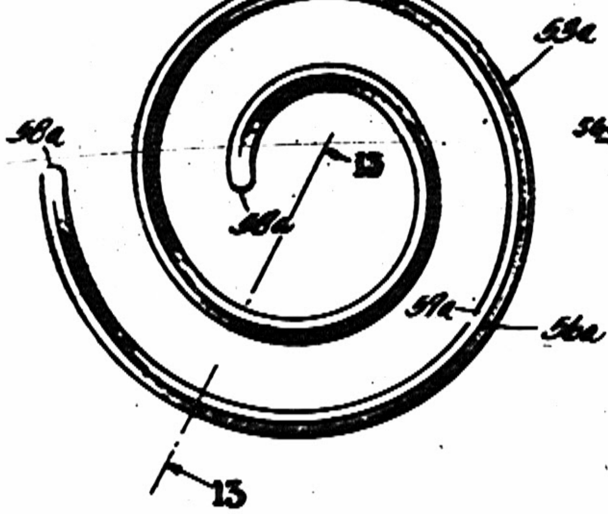


FIG. 13

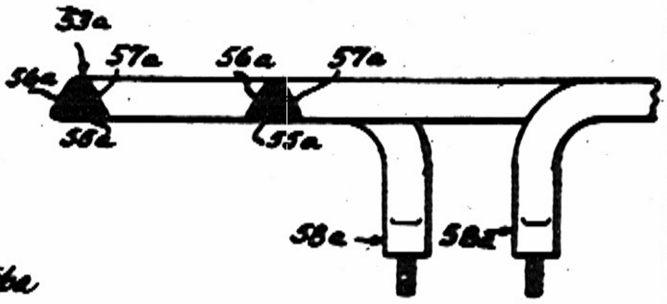


FIG. 14

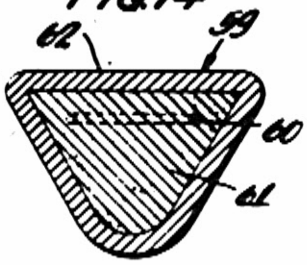


FIG. 15

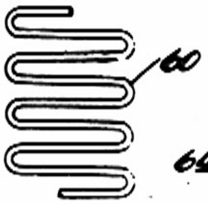


FIG. 16

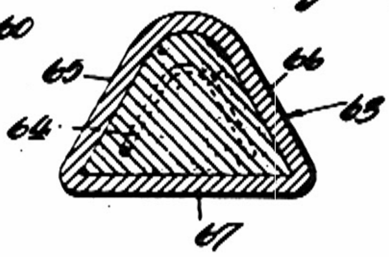


FIG. 17

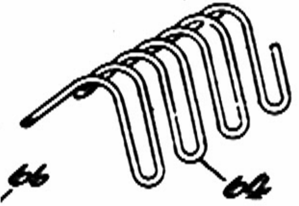


FIG. 18

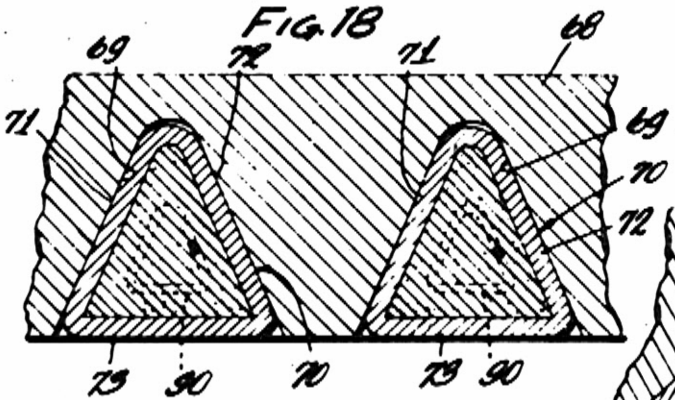


FIG. 19

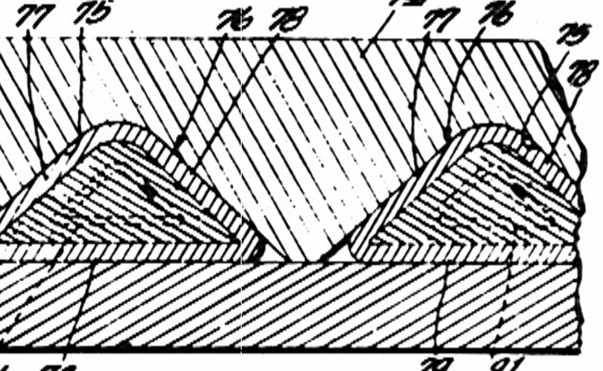
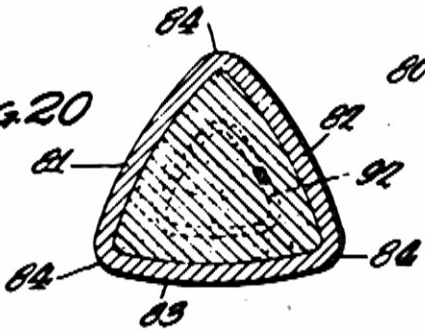


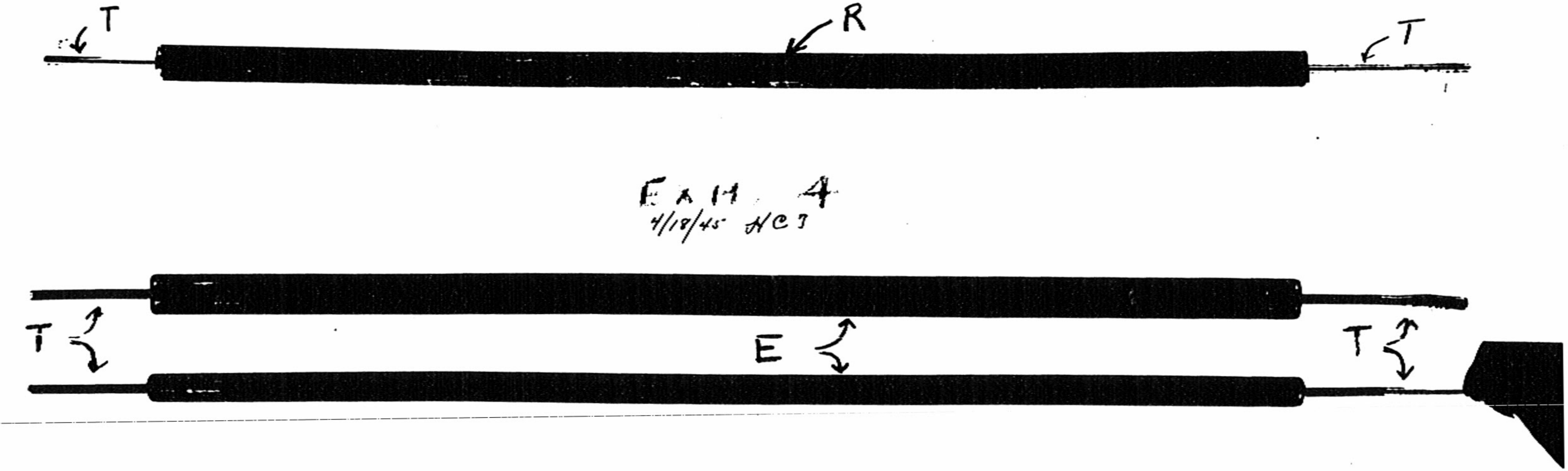
FIG. 20



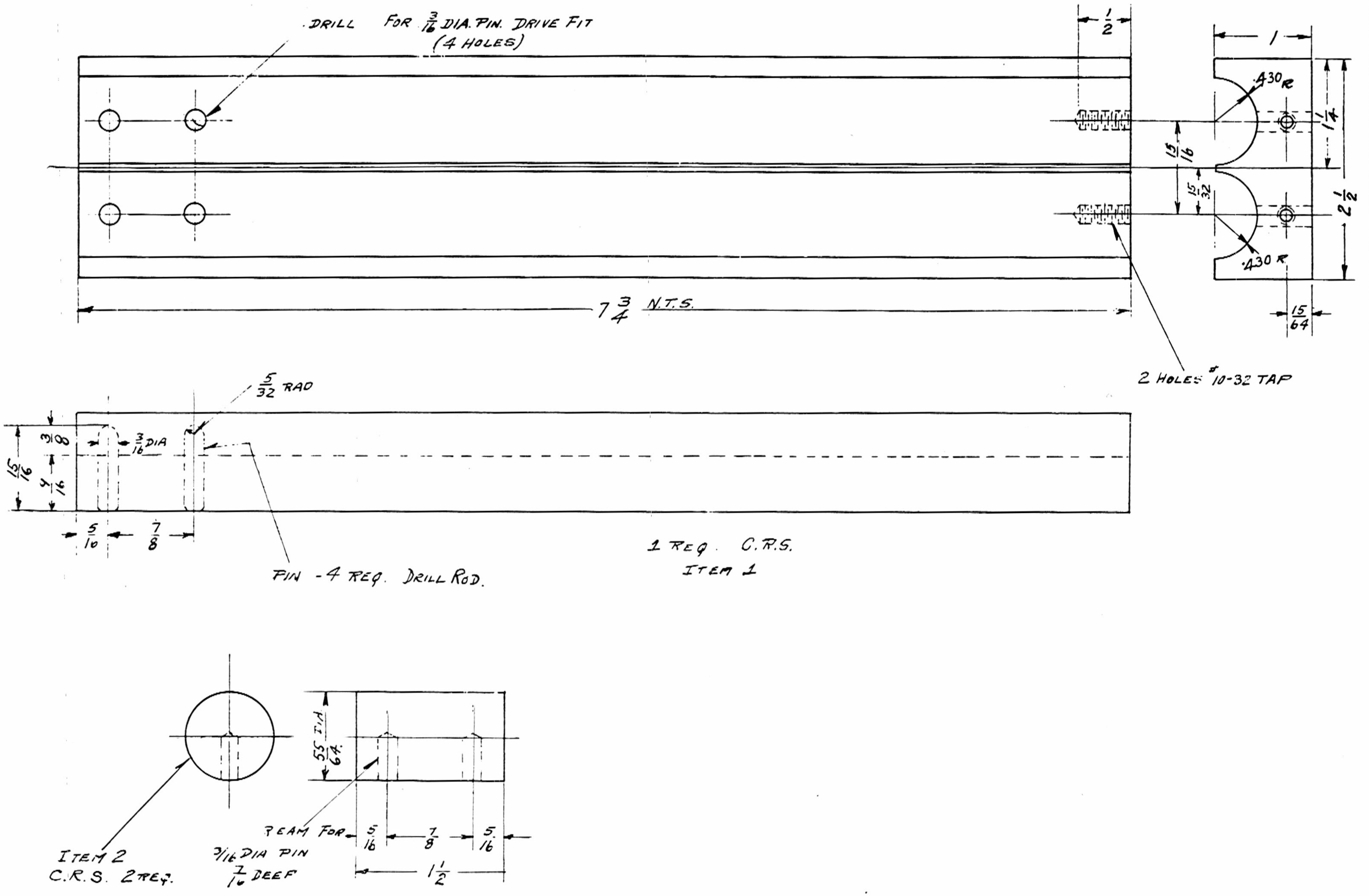
EDWIN L. WIEGAND
INVENTOR

BY Freeman Sweet and Albrecht

ATTORNEYS



Exh. 4
4/18/45 HCJ



WATTS | VOLTS | HEATS | DWG. NO. 469

EDWIN L. WIEGAND CO.
PITTSBURGH, PA.

TITLE:- WINDING FORM FOR CYLINDER TYPE
ONSTS BY FLAT PROCESS

SCALE: 1:1 DETAIL OF MOULD. DIMENSIONS IN INCHES

DRAWN BY F. DEINERT
APPROVED BY
DATE 6-22-28

Exhibit No. 5
4/18/45 HCT

Exhibit No. 6
4/18/45 H.C.T.

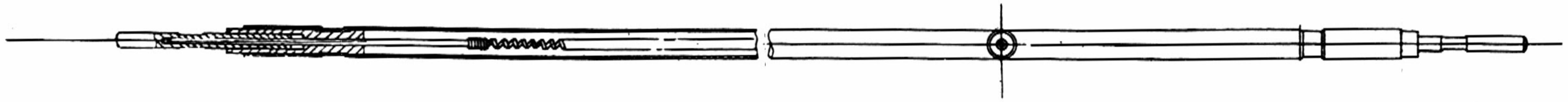


FIG. 1 - STAIGHT TUBULAR HEATER.- ROUND SECTION.

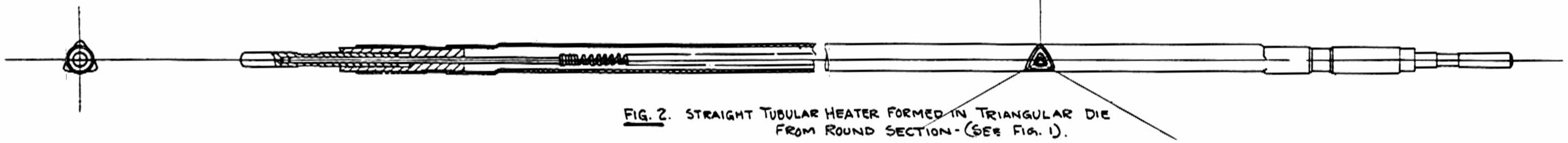


FIG. 2. STRAIGHT TUBULAR HEATER FORMED IN TRIANGULAR DIE FROM ROUND SECTION - (SEE FIG. 1).

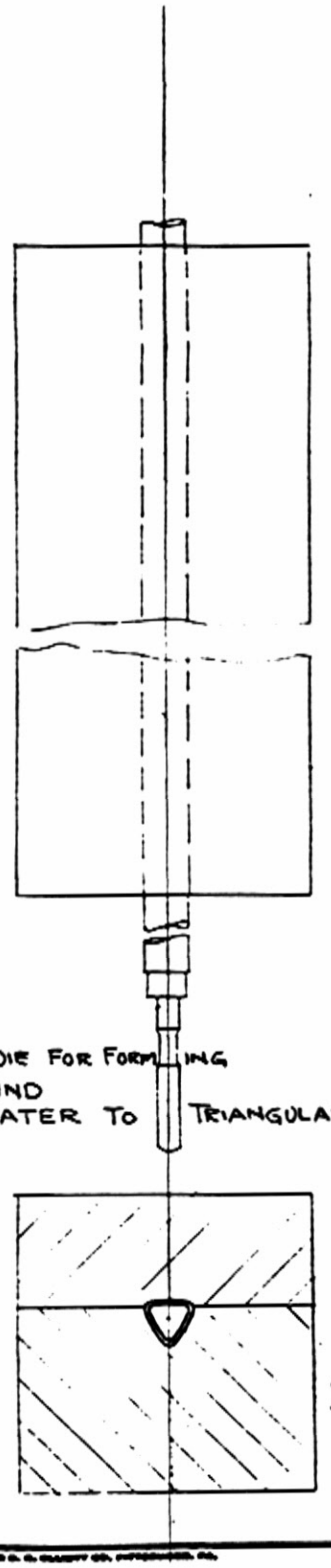


FIG 3
TRIANGULAR DIE FOR FORMING STRAIGHT ROUND TUBULAR HEATER TO TRIANGULAR SECTION

SECTION OF DIE.

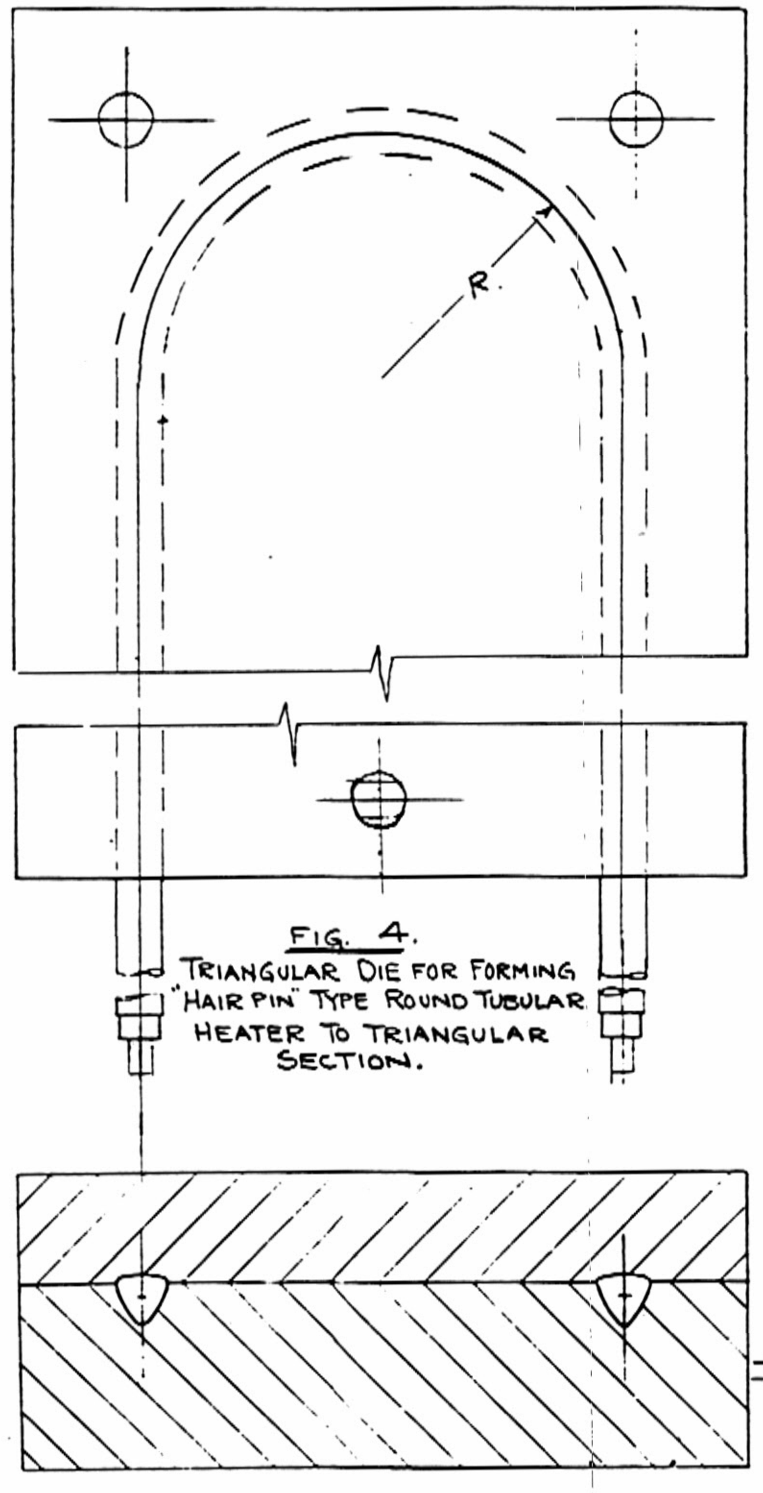


FIG. 4.
TRIANGULAR DIE FOR FORMING "HAIR PIN" TYPE ROUND TUBULAR HEATER TO TRIANGULAR SECTION.

-SECTION OF DIE.-

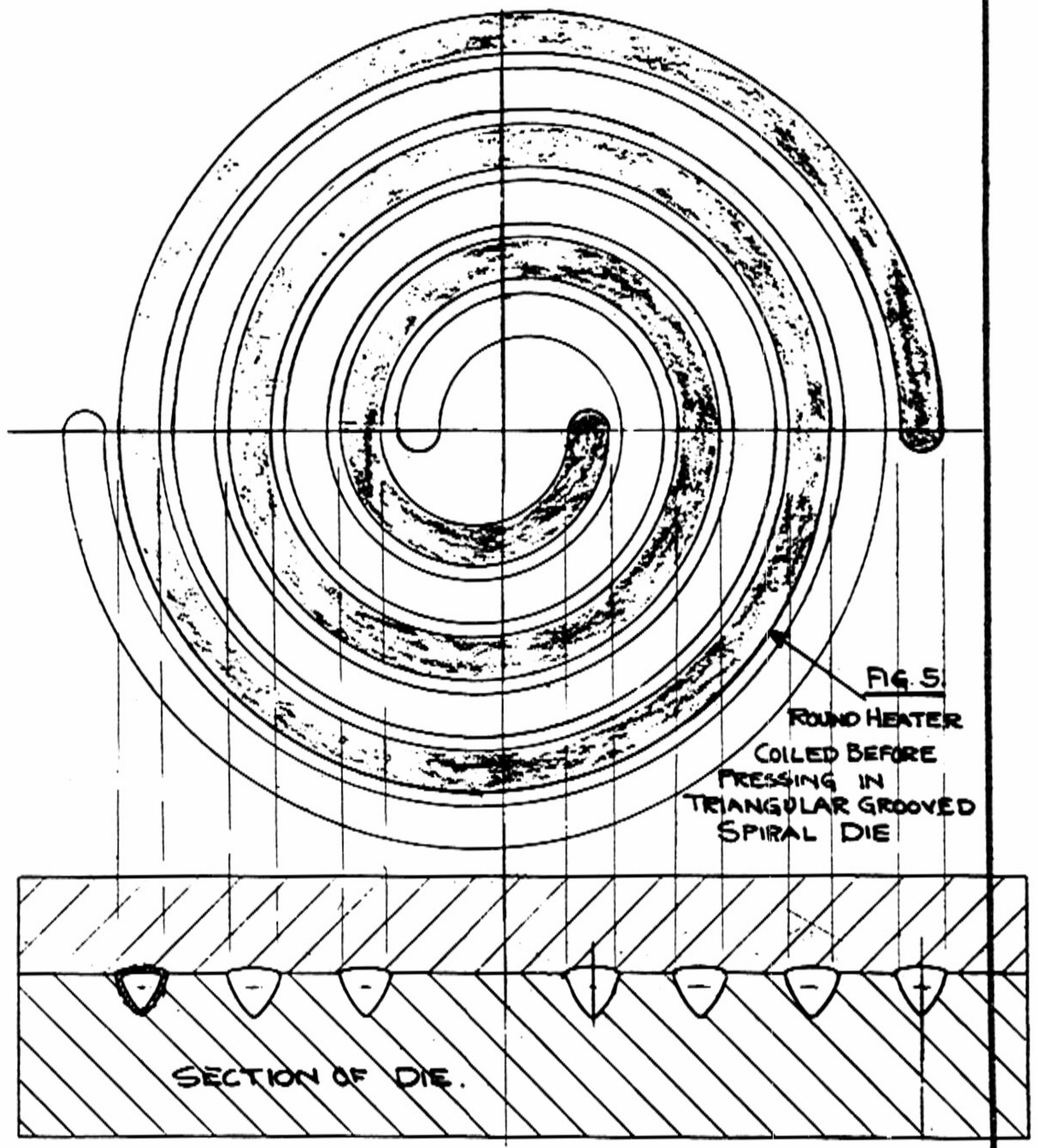


FIG. 5.
ROUND HEATER COILED BEFORE PRESSING IN TRIANGULAR GROOVED SPIRAL DIE

SECTION OF DIE.

MATERIAL | PATT. NO. | REF. DWG. NO. | DWG. NO. AC-3721
WATTS | VOLTS | HEATS | NO. OF SHEETS | SHEET NO.

EDWIN L. WIEGAND CO.
[illegible]
MANUFACTURERS OF
CHROMALOX
[illegible]
PITTSBURGH, PA.

TITLE— LAYOUT AND METHOD OF PRODUCING A TRIANGULAR SHAPED TUBULAR HEATER FROM A ROUND TUBULAR HEATER.
SCALE— DIMENSIONS IN INCHES.
DRAWN BY
APPROVED BY
DATE 10-18-37

[illegible] Exhibit 7-A 4/18/45 HCT [illegible]

[illegible]

v.

[illegible]

[illegible]

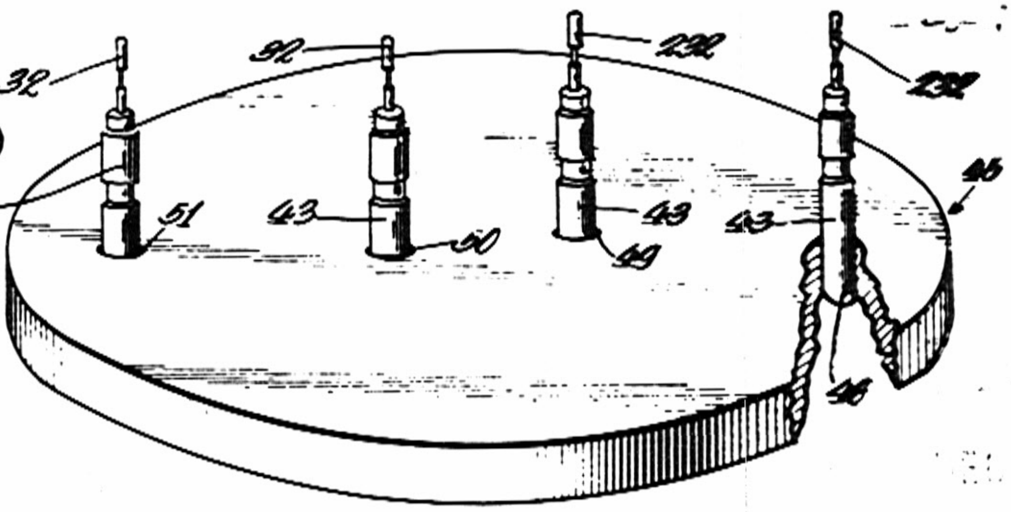


Fig. 9

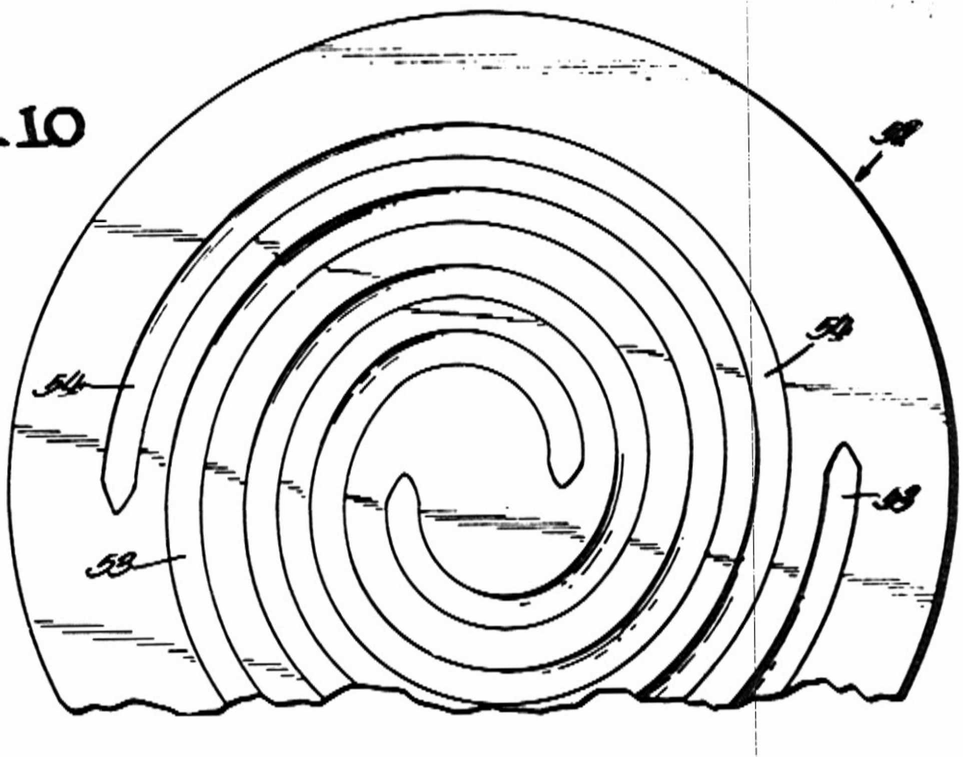


Fig. 10

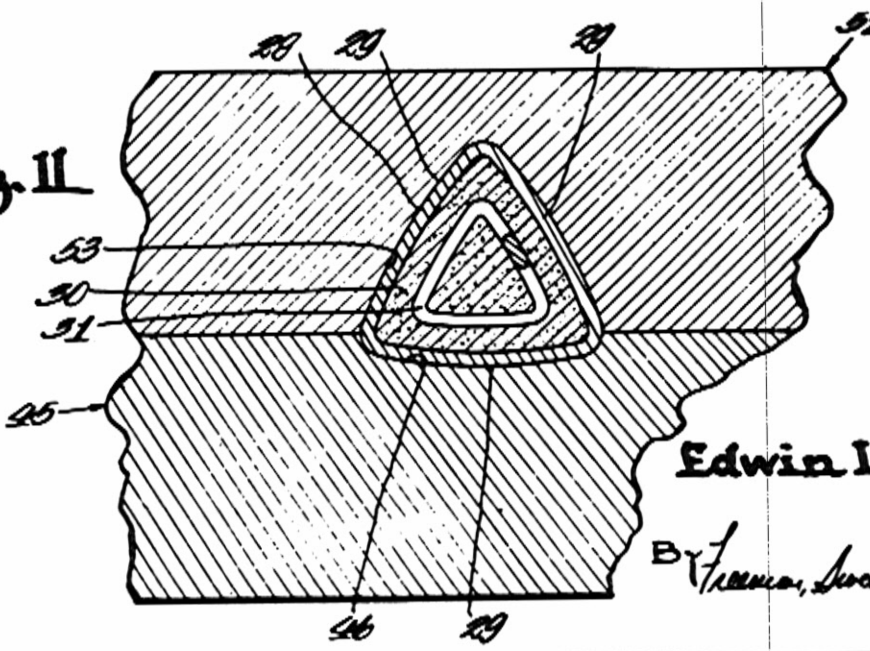


Fig. 11

Edwin L. Wiegand
INVENTOR

BY Freeman, Sweet, Albrecht, and Weidman
ATTORNEYS

[illegible] Exhibit No. 7 - B [illegible]
4/18/45 H.C.T.

[illegible]

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Fig. 12

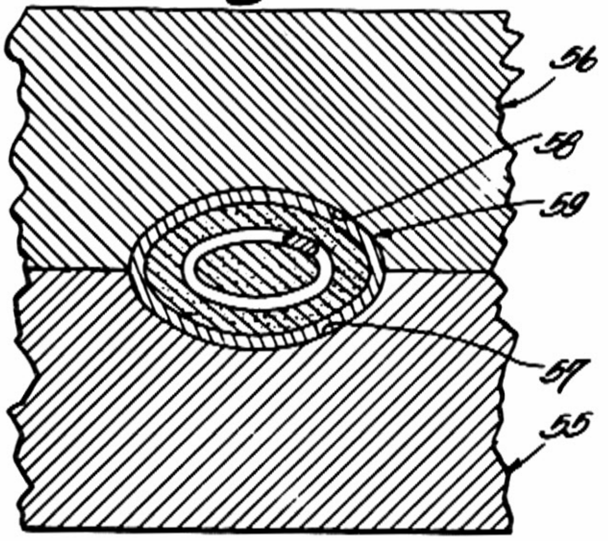
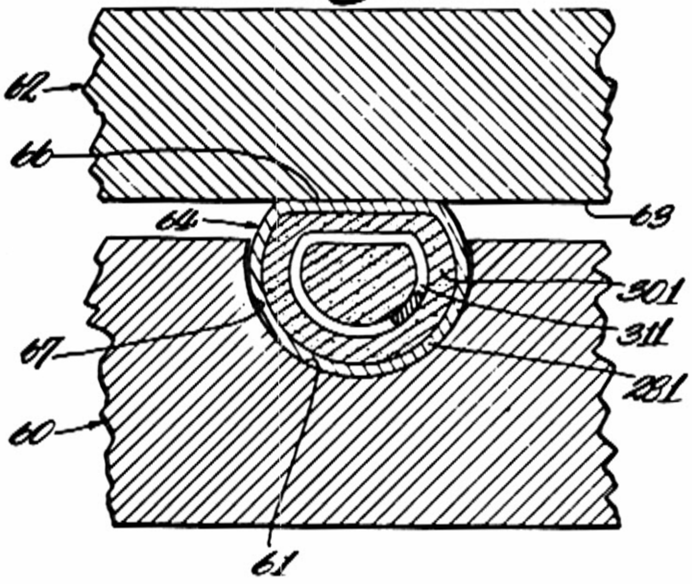


Fig. 13



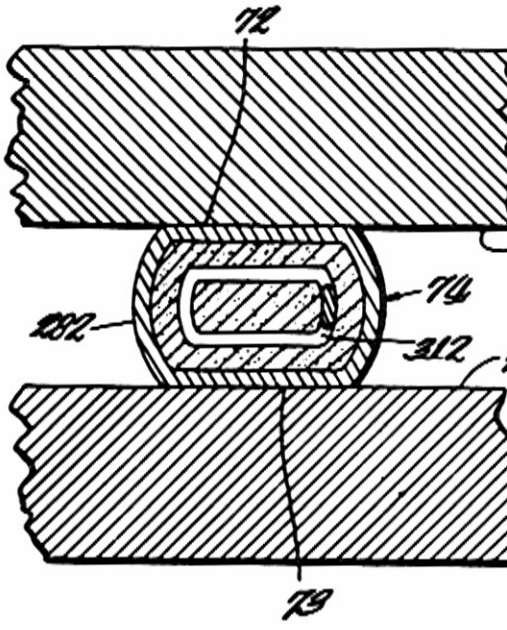


Fig. 14

Fig. 15

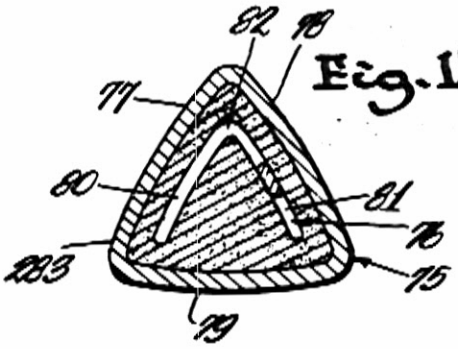


Fig. 16

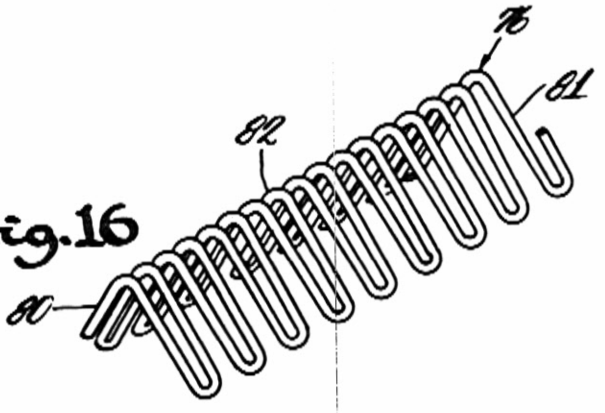
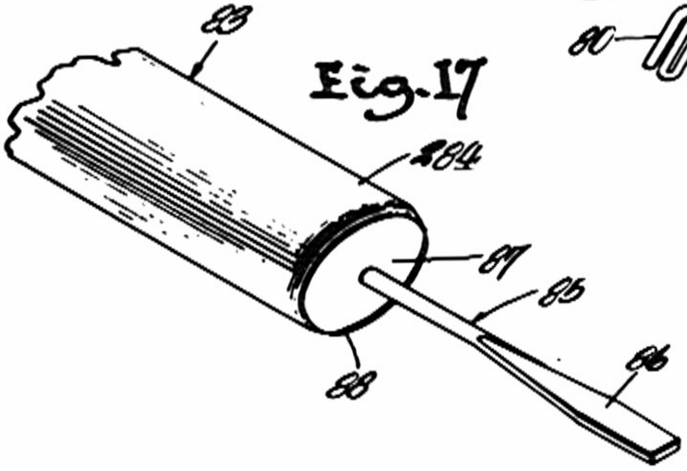


Fig. 17

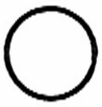
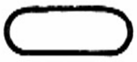
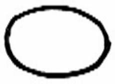
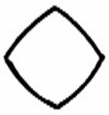
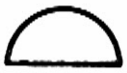
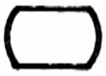
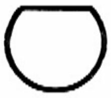
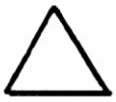


Edwin L. Wiegand
INVENTOR

BY Freeman, Sweet, Albrecht and Weidman
ATTORNEYS

COMPARISON OF SECTIONS

CONSTANT AREA (.0747)□" & CONSTANT WALL (.031")

SECTION		RELATIVE MINIMUM RESISTANCE TO BENDING	RELATIVE RATIO OF PERIMITER TO CROSS SECTION
PRIOR CIRCULAR		260	1298
BACKER FIG 1.		140	1486
BACKER FIG 2.		175	1400
BACKER FIG 3.		298	1459
BACKER FIG 4.		136	1500
VOGEL FIG 3		205	1430
VOGEL FIG 4		230	1416
WIEGAND FIG 8		400	1670

Excerpts from Defendant's Exhibit No. 1.

Sept. 28, 1937. O. G. VOGEL **2,094,480**

ELECTRIC HEATER

Filed May 16, 1936

Fig. 1.

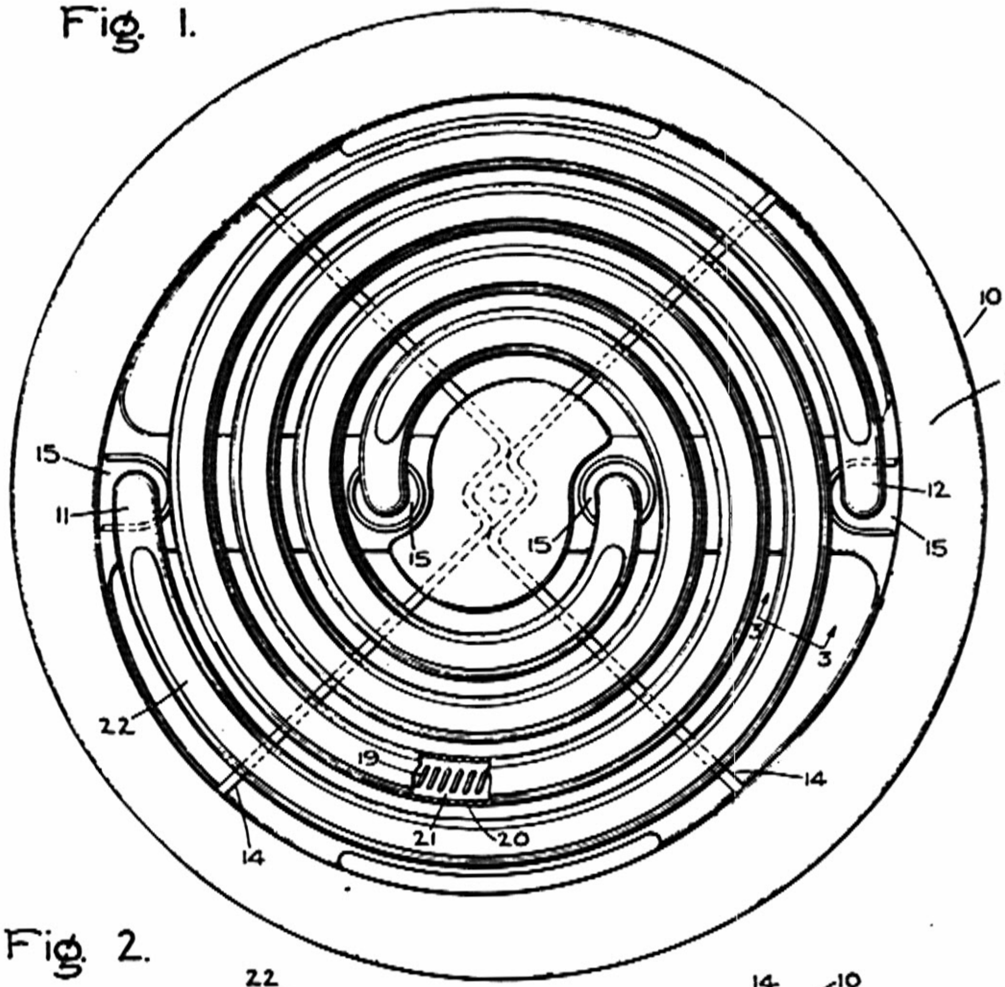


Fig. 2.

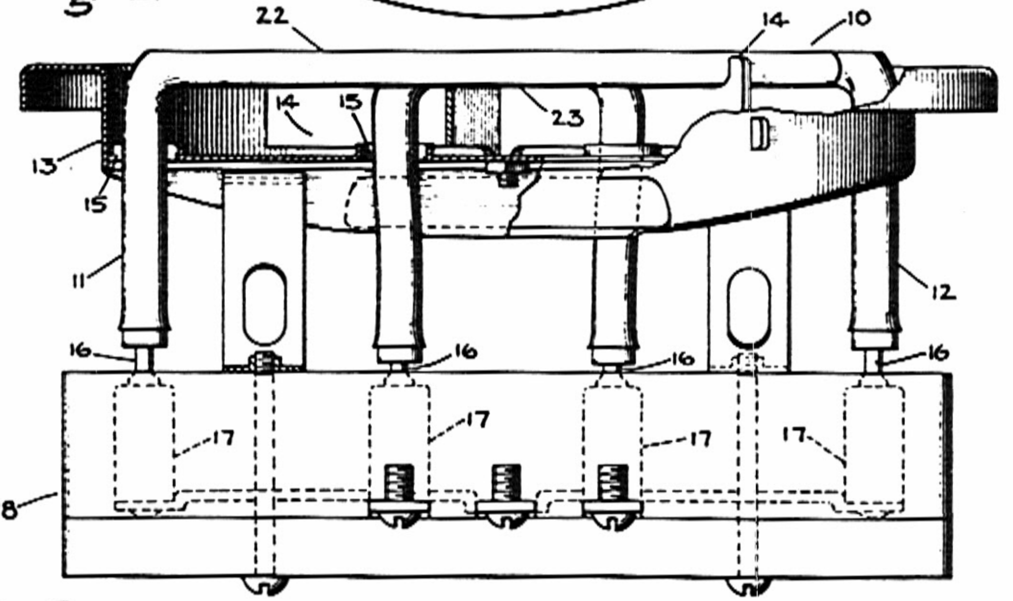


Fig. 3.

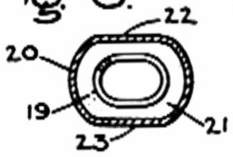
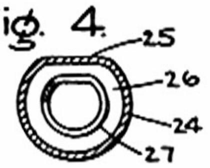


Fig. 4.



Inventor:
Oliver G. Vogel,
by Harry E. Dunham
His Attorney.

Patented Sept. 28, 1937 **2,094,480**

UNITED STATES PATENT OFFICE

2,094,480

ELECTRIC HEATER

Oliver G. Vogel, Oak Park, Ill., assignor to Edison General Electric Appliance Company, Chicago, Ill., a corporation of New York

Application May 16, 1936, Serial No. 80,075

7 Claims. (Cl. 201—66)

This invention relates to electric heaters, more particularly to electric heaters of the encased type, and it has for its object the provision of an improved heater of this character.

This invention has particular application to sheathed electric heaters of the type described in the U. S. Patent to C. C. Abbott, No. 1,367,341, dated February 1, 1921. It is to be understood, however, that this invention is not limited to the specific sheathed heater disclosed in this patent, but is generally applicable to electric heaters having a resistance conductor encased in a metallic sheath.

These sheathed or encased heaters comprise a resistance heating element enclosed in a metallic sheath or casing, and embedded in and supported in spaced relation with respect to the sheath or casing by a densely packed mass of heat refractory and heat conducting, electrically insulating material, such as magnesium oxide.

Heating units of the type described in the Abbott patent when used in electric ranges and like applications where it is desirable to obtain a concentrated heat generation in a limited area are generally given a curved, spiral, or similar nonrectilinear shape. The unit is initially made into straight lengths and is then given the desired shape.

It has been found that the formed heaters, that is, the non-rectilinear heaters do not have as long a life or as great a dielectric strength as do the straight length heaters.

The loss of life and dielectric strength apparently is due to the fact that cracks or fissures are set up in the insulating mass when the heater is shaped. These cracks are the most prevalent at the bent or curved sections of the heater, and become increasingly great the sharper the bend.

Now when sheathed heaters are operated at elevated temperatures, such as 1200° to 1600° F., both the sheath and resistance conductor tend to vaporize. The metallic vapors apparently penetrate the refractory insulating material through the cracks and react either with the refractory material, or with the impurities therein that are always present to a more or less extent, or with both to form conducting paths. This not only weakens the heater dielectrically, but also reduces its life.

I have found that if the sheath, after the heater has been given its final shape, be distorted at the formed sections, as by a flattening operation, the insulation will be redistributed and rearranged and more densely compacted so as to substantially eliminate cracks present in the insulating mass. I have found that formed electric heating units arranged in accordance with this invention can be operated at very high temperatures, such as 1200° to 1600° F., and that the life of the heater has been materially extended over the heaters used prior to this invention. I furthermore have found that the initial dielectric strength of the heater is greater and that it maintains a greater dielectric strength throughout its life.

For a more complete understanding of this invention, reference should be had to the accompanying drawing in which Fig. 1 is a top plan view of an electric range heating unit embodying this invention; Fig. 2 is an elevation of the heating unit shown in Fig. 1, parts being shown in section and parts being broken away so as to illustrate certain details of construction; Fig. 3 is a sectional view taken through the line 3—3 of Fig. 1; and Fig. 4 is a sectional view similar to Fig. 3 but illustrating a modified form of this invention.

Referring more particularly to Figs. 1–3 of the drawing, this invention has been shown as applied to an electric range heating unit of the type described in the United States patent to C. F. Mallett, No. 1,837,975, dated December 22, 1931. It is to be understood, however, that this invention is not limited to electric range heaters, but has application in general to sheathed electric heaters which are intended to be used in various other electrically heated devices that are to be operated at elevated temperatures such as temperatures ranging as high as 1200° to 1600° or more Fahrenheit. Moreover, it is to be understood that this invention is not limited to the specific sheathed heater of the above Abbott patent, but is generally applicable to incased heaters.

As shown in the drawing, the electric range heating unit **10** comprises a pair of sheathed heating elements **11** and **12**. Each heating element has a spiral form, and the ends of each unit are turned downwardly, as shown in Fig. 2. The two spiral heating elements **11** and **12** are supported in a suitable pan-like receptacle **13** on suitable truss-like supports **14** mounted in the pan.

The coils **11** and **12**, as shown, are nested one within the other, and moreover, are arranged so that the down-turned ends respectively of the units are positioned on opposite sides of the center of the pan. The down-turned ends of the two coils pass freely through apertures **15** provided for them in the bottom of the pan **13**. The ends of these down-turned ends have suitable

terminals 16 which are received in contact springs 17 mounted in a suitable terminal block 18.

Each heating element 11, 12 is of the sheathed type, such as described and claimed in the United States patent to C. C. Abbott, No. 1,367,341, dated February 1, 1921. As described in this patent, each heating element comprises a helical or sinuous resistance conductor 19 mounted centrally of a metallic sheath 20. The resistance conductor 19 is embedded in and supported in spaced relation to the sheath by means of a highly compacted mass 21 of heat refractory and heat conducting, electrically insulating material, such as powdered magnesium oxide. The powdered magnesium oxide may be highly compacted by reducing and elongating the metallic sheath 20 after the resistance conductor has been mounted in the sheath and the sheath has been loaded with the oxide, as fully pointed out in the above-mentioned Abbott patent.

It will be understood that these heating units are formed in straight sections, that they can be bent into any desired form and when so bent form a structure sufficiently rigid to stand frequent handling without loss of shape. Thus, in forming the spiral heaters 11 and 12, each heater will be made initially as a straight rod-like element. This element will then be wound spirally by any suitable means into its final form shown in Fig. 1, and its terminal ends will be bent as indicated.

While the sheath 20 may be formed of any suitable metal that is capable of operating for relatively long periods of time at very high temperatures, it is preferable that the sheath be made in accordance with the disclosure in the United States patent to J. C. Sharp, No. 2,034,539, dated March 17, 1936.

As pointed out previously, it has been found that the formed heaters do not have as high a dielectric strength and do not have as long a life as do the same heaters in their straight form. As also pointed out previously, when the windings are formed, that is, when they are turned or bent from their rectilinear shape, small fissures or cracks are set up in the insulating mass 21 in the bent portions of the unit. When the metallically sheathed heater is operated at very high temperatures, such as 1200° to 1600° F., the metals of the resistance conductor 19 and of the sheath 20 tend to vaporize, and the metal vaporization penetrates the magnesium oxide 21 through the cracks and fissures. Apparently, the metal vapors react with the oxide and with impurities therein so as to weaken the heater dielectrically, and to reduce its life materially In other words, it is believed that paths are set up having a comparatively low electrical resistance and other undesirable characteristics.

To obviate this difficulty and thereby to increase materially the dielectric strength of the heater and also its life, I deform the metallic sheath 20 after the heater has been given its desired shape. In the form of the invention shown in Figs. 1, 2 and 3, the deforming of the sheath is accomplished by subjecting the opposite sides of the unit to a suitable operation so as to form flattened portions 22 and 23 on the top and bottom portions of the sheath. The flattening operation may be accomplished in any suitable manner, such as by means of a suitable hammering or pressing machine.

It has been found that this reshaping of the sheath after the heater has been formed redistributes the insulating material 21 and gives it a greater density so that a substantially uniform homogeneous layer of insulating material is provided around and about the conductor. All cracks and fissures that might have been formed when the heater is given its curved shape are eliminated. The elimination of the fissures and cracks prevents the emission of vapors into the insulating layer.

If desired, and in certain cases it has been found preferable to do so, the sheath may be deformed on one side only, as shown in Fig. 4. In this figure, the sheath 24 is deformed on its upper side only so as to provide the flattened portion 25. This flattening redistributes the insulating material 26 around and about the conductor 27 as in the previous case, but in certain cases to even a greater extent. Moreover, it has been found that the over-all density of the insulation is greater in the form of Fig. 4.

In each case, it will be observed that the resistance coils 19 and 27 take substantially the general cross-sectional form of the finished heater, as shown clearly in Figs. 3 and 4. This has the advantage that substantially the same thickness of insulating material is maintained between all parts of the resistance conductor and the adjacent walls of the sheath.

It is not necessary to deform the terminal sections of the heater, because these portions of the heater operate at relatively low temperatures.

This invention may be used with success in encased heaters of certain types where the heater is given the desired shape initially, that is, the heater is not given a final bending or shaping step. For example, it is applicable to those heaters which are provided with casings having a shape substantially the shape that the finished heater is to have; often-times in these heaters, the insulating material is not uniformly distributed throughout the casing with the result that the heater has a relatively low initial dielectric strength, a falling dielectric characteristic as the heater ages and a relatively short life. If the casing in such cases be given a final compressing or impacting operation in accordance with this invention, the insulating material will be redistributed and will have a uniform and substantially greater density throughout. This, as pointed out before, increases the life of the heater and improves its dielectric characteristics.

Also I have found that in the case of the above Abbott heater, the sheath need not be given a normal complete swaging operation, but may be partially swaged, and then subjected to the impacting or compressing step of this invention. In other words, the heater in straight form, after being loaded and swaged to partially compact the insulating material, is then given its final curved or non-rectilinear shape. Then the insulating material is redistributed and compacted in accordance with this invention. This insures a densely packed uniformly distributed layer of insulating material around and about the resistance conductor.

As a result of this invention, I have found that the life of encased heaters has been materially increased. Moreover, I have found that the initial dielectric strength of the heater has been greatly improved and that the dielectric strength is maintained throughout the life of the heater to a far greater extent than before.

This invention may be used to advantage in high temperature metallically encased electrical heaters in general, particularly is it useful in those cases where the insulating material and resistance conductor are loaded in the casing and

the heater thereafter completed in the normal manner. The subsequent deforming of the casing in accordance with this invention insures a densely compacted mass of insulating material around and about the conductor, and thereby increases the life and dielectric strength of the heater.

Moreover, in electric range heating units and the like where the cooking utensil to be heated is placed upon the unit, my invention has the further advantage that the flattened top side of the sheath provides a relatively large surface for the conduction of heat to the utensils placed on it. This increases materially the speed of the cooking operation and the efficiency of the heating unit.

While I have shown particular embodiments of this invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of making an electric heater having a predetermined non-rectilinear form and capable of operating at relatively high temperatures, such as 1200° to 1600° F., during a relatively long life, which comprises inserting a resistance conductor in a metallic casing, filling the space around said conductor with heat refractory electrically insulating material, compacting said material to a hard dense mass so that it readily conducts heat from said conductor to the walls of said casing, shaping said casing to give it said predetermined form, and then deforming said casing sufficiently to redistribute said insulating material in the shaped sections of the casing to eliminate any cracks or fissures that are formed in said hard dense mass when said casing is shaped, and thereby obviate paths in said mass through which metallic vapors may pass.

2. The method of making an electric heater having a predetermined non-rectilinear form and capable of operating at relatively high temperatures, such as 1200° to 1600° F., during a relatively long life, which comprises inserting a helically wound resistance conductor in a metallic casing, filling the space around said conductor with heat refractory electrically insulating material, compacting said material to a hard dense mass so that it readily conducts heat from said conductor to the walls of said casing, shaping said casing to give it said predetermined form, and then compressing at least a wall of said casing in the shaped sections thereof to flatten it sufficiently to redistribute said insulating material in the shaped sections to eliminate any cracks that are formed in said hard dense mass when said casing is shaped to give it said predetermined form and also, to flatten the portions of the turns of said resistance conductor opposite said wall so as to insure a layer of insulating material of substantially uniform thickness between all parts of said resistance conductor and casing.

3. The method of making an electric heater capable of operating at relatively high temperatures, such as 1200° to 1600° F., during a relatively long life, which comprises inserting a resistance conductor in a metallic casing, filling the space around said conductor with a heat refractory electrically insulating material, highly compacting said material around said conductor to a hard dense mass so that it readily conducts heat from said conductor to the walls of said casing, and then flattening at least a wall of said casing to insure a substantially uniform distribution of said insulating material around said conductor and the elimination of any cracks or fissures that might be generated in said material after it has been compacted to said hard dense mass and through which metallic vapors may pass.

4. The method of making an electric heater having a section of predetermined non-rectilinear form and capable of operating at relatively high temperatures such as 1200° to 1600° F. during a relatively long life which comprises mounting a resistance conductor in a metallic sheath, filling the space around said conductor with a powdered, heat refractory electrically insulating material, reducing and elongating said sheath sufficiently to highly compact said insulating material around said resistance conductor, bending said sheath to give it said section of predetermined non-rectilinear form and then flattening said sheath at said section on opposite sides of a diameter to redistribute said insulating material in said section and thereby eliminate cracks that are formed during said bending step.

5. The method of making an electric heater having a section of predetermined non-rectilinear form and capable of operating at relatively high temperatures such as 1200° to 1600° F. during a relatively long life which comprises mounting a resistance conductor in a metallic sheath, filling the space around said conductor with a powdered, heat refractory electrically insulating material, reducing and elongating said sheath sufficiently to highly compact said insulating material around said resistance conductor, bending said sheath to give it said section of predetermined non-rectilinear form and then flattening said sheath at said section on one side to redistribute said insulating material in said section and thereby eliminate cracks that are formed during said bending step.

6. The method of making a heating unit for electric ranges and the like having a predetermined curve form substantially throughout its length and capable of operating at elevated temperatures, such as 1200° to 1600° F., which comprises mounting a helical resistance conductor in a metallic sheath, filling the space around and about said conductor with powdered heat refractory, electrically insulating material, reducing and elongating said sheath sufficiently to compact said insulating material into a hard dense mass, then shaping said sheath to give it said predetermined curved form substantially throughout its length and then flattening a wall of said sheath at least throughout the length of the curved portion of the sheath so as to eliminate any cracks in said mass of insulating material developed in the shaping step.

7. A high-temperature high-speed heating unit for electric ranges and the like wherein the utensil to be heated is placed upon and in contact with the unit comprising a heating rod-like element in the shape of a flat helix and consisting of an outer metallic sheath, a helically wound resistance conductor within the sheath, and powdered heat conducting, electrically insulating material insulating the helically wound resistance conductor from said sheath, the insulating material being compacted to a hard dense mass, and the sheath thereafter being shaped into said spiral form, and the top wall of said

sheath being flattened after said insulating material has been compacted and the sheath has been given said spiral form to compress the insulating material so that it completely fills the space between said helically wound resistance conductor and sheath to avoid any fissures which might permit metallic vapors to provide conducting paths between said resistance element and said sheath when the energy supplied to the heating unit raises the temperature of the sheath to the order of 1200° to 1600° Fahrenheit, and further, so that the flattened exterior of the element provides a relatively large surface for conduction of heat to the utensil adapted to be placed upon and in contact therewith.

OLIVER G. VOGEL.

May 9, 1939. C. B. BACKER **2,157,884**

ELECTRIC HEATING ELEMENT

Filed Jan. 16, 1936

Fig. 1.

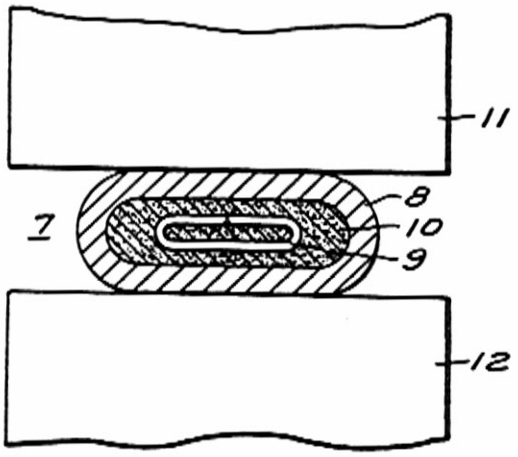


Fig. 2.

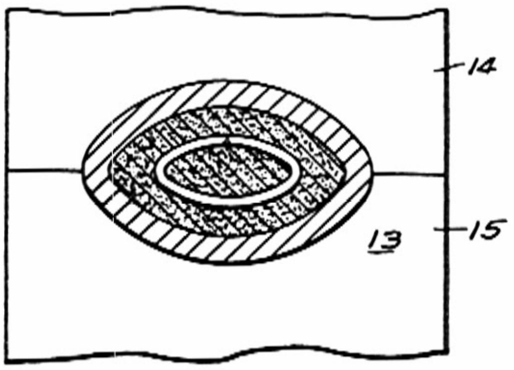


Fig. 3.

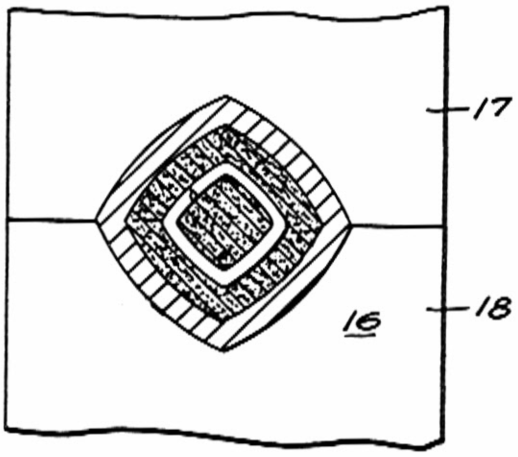


Fig. 4.

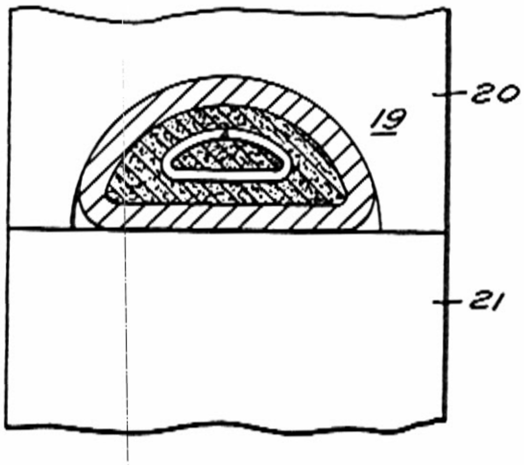
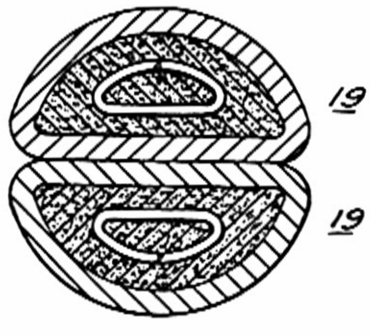


Fig. 5.



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ATTORNEY

Patented May 9, 1939 **2,157,884** 107

UNITED STATES PATENT OFFICE

2,157,884

ELECTRIC HEATING ELEMENT

Christian B. Backer, Ottawa, Ontario, Canada

Application January 16, 1936, Serial No. 59,391
In Canada May 21, 1935

8 Claims. (Cl. 201—64)

My invention relates to electric heating elements and more particularly to tubular heating elements in which the coiled resistance wire with its surrounding insulation is enclosed in a metallic tube or sheath.

There are on the market two types of such tubular heating elements, namely, the so-called "Calrod" element and the "Backer" tube element. In the "Calrod" element the resistance coil is surrounded by a powdered insulation material (generally magnesium oxide which has been fused and powdered), which is compacted around the resistance coil by "swaging" (hammering) the tube so as to reduce its diameter. In the "Backer" tube element, on the other hand, the insulation consists of chemically pure crystalline magnesium oxide, which is produced in place from magnesium metal by treating the metal with steam or water under very high pressure and temperature, whereby the magnesium metal is converted into magnesium hydroxide, which is further converted into magnesium oxide by heating to dull red heat.

A "Backer" tube element is made as follows: Into a metal tube we insert three magnesium metal strips bent into segmental shape so as to form in effect a magnesium lining inside the metal tube. (Instead of the three segmental strips, a magnesium metal tube may, of course, be used, although that would be much more expensive than the strips.) The coiled resistance wire is now inserted into the tube and held in position at both ends. The assembled element, consisting of the outer tube or sheath, the magnesium metal lining and the coiled resistance wire, is now placed vertically in an autoclave nearly full of water, so that the tube is preferably covered with the water. The autoclave is then closed and heated until the steam pressure is at least 15 atmospheres, and the temperature corresponds to that of the saturated steam pressure used. (A much higher pressure than 15 atmospheres may be used with advantage, as the process goes faster with higher pressure and temperature.) The water now combines with the magnesium metal to form magnesium hydroxide, while hydrogen gas is liberated and escapes through a suitable outlet valve on the autoclave cover.

During the conversion the crystalline magnesium hydroxide formed grows or expands, so that, when the conversion is finished, the hydroxide takes up about twice as large volume as the original magnesium metal, whereby the resistance coil becomes completely embedded in the hydroxide. The tube is now dried at a temperature of dull red heat in order to convert the magnesium hydroxide into oxide. The center opening in the resistance coil (through which the water circulated during the conversion in the autoclave) may now be filled with any good refractory insulation powder, or a magnesium metal wire may be inserted into the center opening and converted in the autoclave into magnesium hydroxide. Thereafter air-tight terminals are attached to the ends of the resistance wire at both ends of the tube, and after a final drying operation the tube element is ready for use.

The "Backer" tube element as described above has already been patented in most industrial countries. See United States Patent Reissue No. 16,340, Canadian Patent No. 309,366, and corresponding British Patent No. 336,949. My present patent application covers an important improvement in the above described tubular element.

As stated above the magnesium hydroxide must be heated to dull red heat to convert it to magnesium oxide free from water. During this drying process, which must be done at a temperature of about 600 degrees C., the magnesium oxide shrinks, as it loses its water. The result is that circumferential cracks develop in the oxide. These cracks or openings are very objectionable since they make it impossible to produce tube elements which can be flash tested with more than 1500 volts, when the tube is cold, or 800 volts, when the tube is red hot. For many purposes approval specifications call for flash test of the elements with as high a voltage as 1200 or 1500 volts, when the element is up to its maximum temperature, that is, dull red heat, and for 550-volt service the elements must be flash tested with 2100 or 2200 volts.

One object of my invention, therefore, is to provide an improved heating element of the metal-clad or sheathed type.

Another object of my invention is to provide a novel method of compressing or compacting the insulating material in a well-known sheathed type of heating element to increase the dielectric strength thereof.

A further object of my invention is to effect such compression or compacting of the insulating material, or deformation of the complete element, in a plurality of steps in conjunction with selected temperature treatments, whereby the desired compacting and deformation is effected without undue strains in the insulating material, which would otherwise develop deleterious cracks.

Other objects of my invention will become evident from the following description thereof

2[illegible]3

taken in conjunction with the accompanying drawing, wherein:

Figs. 1 to 5, inclusive, are cross-sectional views of heating elements deformed in different ways in accordance with my present invention, together with elevational views of simple dies for effecting the desired deformation in each case.

I have developed a new method of deforming the tube or heating element, after it has been baked in the autoclave, so that the magnesium oxide becomes very compacted and may be dried at any temperature without developing any cracks. I proceed as follows: The tube element may be such as that designated generally by reference character **7** in Fig. 1, comprising the outer metallic tube or sheath **8**, the coiled resistance wire **9** (initially an ordinary helical coil) and the intervening insulating material **10**. After the tube element has been treated in the autoclave as described above, it is dried in a suitable drier at a temperature of from 330 to 350 degrees C. A drying period of 30 to 60 minutes is satisfactory. By this drying the magnesium hydroxide loses a part of its bound hydroxide water, without being completely converted into oxide. No objectionable cracks or openings develop in the magnesium hydroxide when it is dried at only 350 degrees C. Nevertheless, it loses sufficient water and becomes considerably softer, so that it may be easily compacted.

After this first drying operation the center opening in the element is filled with insulation powder and the terminals are assembled into both ends of the tube. Then the tube is submitted to the first deforming operation by pressing it in a suitable die, so that the insulation becomes compacted, or reduced, in volume, the volume reduction in this first deforming operation may be from 15% to 25%.

The simplest method of deforming the tube is to press it between two flat dies **11** and **12**, as simply illustrated in Fig. 1. The tube then takes a more or less rectangular cross section, with half circular sides, as shown in Fig. 1. Although this shape of the tube is cheaply attained, because it requires only flat dies, and although a tube element flattened as shown in Fig. 1 is very much better in every respect than a tube which has not been deformed at all, it is not entirely satisfactory, because, if the tube is to be flattened enough to sufficiently compact the oxide at the rounded sides of the tube, the thickness of the oxide layer at the flattened sides becomes too small.

A much better shape is shown at **13** in Fig. 2, which is more or less elliptical, rather than rectangular. To deform the tube into a shape as shown in Fig. 2 requires a set of dies **14** and **15** with grooves of the corresponding form, as indicated. In this shape an evenly compacted oxide is attained without reducing the thickness of the insulation layer at any point to an objectionable degree. I have found that the shape as shown in Fig. 2 is the most desirable one, and gives a perfect result.

Another shape, shown in Fig. 3 at **16**, also gives very good results. It is more or less square except that the sides of the square are slightly rounded, the cooperating dies **17** and **18** being correspondingly shaped, as indicated. This rounding of the sides is desirable, because in a section with straight flat sides the flat parts of the wall have a tendency to bulge out, when the tube is heated, and thereby destroy the good contact between the tube and the insulation.

Another shape—approxiately semi-circular—which may be desirable for special purposes is shown in Fig. 4 at **19**. A tube shaped as per Fig. 4 by means of suitable dies **20** and **21** may be conveniently bent into hair-pin form and pressed together so as to form a return bend element of approximately circular cross section having the terminals near together at the same end of the element. The cross section of such an element would be as shown in Fig. 5. There may also be other shapes into which the tube may be formed for special purposes.

After the first deforming operation, in which the insulation may be compacted to the extent of 15% to 25% of its volume, the tube is again put into the drier and dried for several hours at about 600 degrees C. This drying operation will convert all the magnesium hydroxide into oxide, without any cracks developing in the insulation. After this final drying the tube is further deformed in the same dies as used for the first deforming operation or in similar dies, as will be understood. In the second deforming operation the tubes are given their final shapes as shown in Figs. 1 to 5, as the case may be, and the oxide insulation is now compacted, so that it occupies about two-thirds of the volume of the original magnesium hydroxide. This great compression of the oxide makes it extremely hard and compact, so that its dielectric strength is increased to more than the double of what it was before the deformation.

It was mentioned above that the well-known "Calrod" tube element is "swaged" (hammered) in a rotating "swaging" machine in order to reduce the diameter of the tube and thereby compact the powder insulation. This "swaging" operation always produces a considerable elongation of the tube (from 10% to 20% elongation), and the circumference of the tube is considerably reduced. The "swaging" operation is fundamentally different from my new deforming method, which is the subject of this patent application. In my deforming operation the circumference of the tube is not decreased by design (although the tube may incidentally get its circumference reduced by anywhere from half of one percent to two percent on account of its wall being slightly compressed at both sides), and the length of the tube is not increased at all. The lengthening of the tube inherent in the "swaging" method is a great drawback, which makes manufacturing difficult in all cases where the tubes must be made to exact length. This difficulty has been eliminated by my deformation method. The fundamental differences between the said "swaging" method (as described in U. S. Patent No. 1,367,341, dated February 1, 1921, and earlier patents such as British Patent No. 18,685, A. D. 1914), and my deformation method are that by the former method a reduction in the circumference and a considerable increase in the length of the tube element are unavoidable, while by my deformation method there is no increase in the length of the tube and the reduction in the circumference is so small as to be hardly measurable.

The deformation of a tube element may be done in a strong press by a single blow of the press. If no large press is available the deformation may also be done in a small press by stages, that is, a little at a time. If this method is used, then there is a very small lengthening of the tube, depending upon how many blows of the press are required to deform the whole length of the tube.

There are also other extremely important differences in the two methods. If a tube with crystalline magnesium oxide insulation (made by converting magnesium metal by steam in an autoclave) is "swaged", the crystalline structure of the oxide is broken up by the thousands of hammer blows, and the insulation becomes a hard mass consisting of extremely fine particles of oxide. By this breaking up of the crystalline structure of the oxide, its heat conductivity is very materially reduced, which has the effect of increasing considerably the temperature difference between the resistance wire and the outer sheath. By the deformation method the crystalline structure of the oxide is not destroyed. The crystals are merely packed closer together, and the good heat conductivity is retained.

I have also found that, if a tube element with crystalline magnesium oxide is "swaged", the insulation resistance of the oxide is decreased to a small fraction of what it was before the "swaging", while the deformation of the tube, as described in this application, does not decrease the specific insulation resistance of the oxide. When a tube element has been deformed, its insulation resistance is a little lower than before the deformation, but the decrease is only in proportion to the decreased thickness of the oxide layer.

From the above it will be realized that the "swaging" method is practically speaking useless for tube elements with crystalline magnesium oxide insulation (made from magnesium metal in an autoclave by the "Backer" insulation process). On the other hand, the "swaging" method is excellent for tube elements made by the "Calrod" powder process. My deformation method could not be successfully used for such elements, because the resistance coil would not deform with the tube, but would have a tendency to remain circular and therefore cut through the insulation layer or reduce its thickness too much.

Various modifications may be made in devices embodying my invention, such as changing the shape into which the tube is deformed, without departing from the spirit and scope thereof, and I desire, therefore, that only such limitations shall be placed thereon as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. The method of making a tubular heating element comprising the steps of disposing a resistance member and moisture-containing material comprising a magnesium oxide compound surrounding said member within a metal tube or enclosing sheath, heating said material to dehydrate it to a considerable degree and initially deforming said sheath to compact said material around said resistance member and close any cracks formed therein by such dehydration, the volume reduction of said material being 15–25%, further heating said material to additionally dehydrate it and further deforming said sheath to additionally compact said material.

2. The method of making a tubular heating element comprising the steps of disposing a resistance member and insulating moisture-containing material surrounding said member within a metal tube or enclosing sheath, partially drying said material and initially deforming said sheath to compact said material around said resistance member, the volume reduction of said material being 15–25%, further drying said material and further deforming said sheath to additionally compact said material, the second volume reduction being of an order similar to that of the first.

3. The method of making a tubular heating element comprising the steps of disposing a resistance member and insulating moisture-containing material surrounding said member within a metal tube or enclosing sheath, drying said material at a temperature of above 300° C. for a predetermined period of time and initially deforming said sheath to partially compact said material around said resistance member, further drying said material at a higher temperature and for a longer period of time than the first-named drying, and further deforming said sheath to additionally compact said material.

4. The method of making a tubular heating element comprising the steps of disposing a resistance member and insulating moisture-containing material surrounding said member within a metal tube or enclosing sheath, drying said material at a temperature of 330° to 350° C. for a period of 30 to 60 minutes and then initially deforming said sheath to partially compact said material around said resistance member, further drying said material at about 600° C. for several hours and further deforming said sheath to additionally compact said material.

5. The method of making a tubular heating element comprising the steps of disposing a resistance member and insulating moisture-containing material surrounding said member within a metal tube or enclosing sheath, drying said material at a temperature of 330° to 350° C. for a period of 30 to 60 minutes and then initially deforming said sheath to reduce the volume of said insulating material by 15% to 25%, further drying said material at about 600° C. for several hours and further deforming said sheath to reduce the volume of said material to about two-thirds of its original volume.

6. The method of making a tubular heating element comprising the steps of disposing a resistance member surrounded by hydroxide within a metal tube or enclosing sheath, partially converting said hydroxide to oxide, initially deforming said sheath to partially compact the hydroxide and oxide, completing the conversion to oxide, and further deforming said sheath to additionally compact the oxide.

7. The method of making a tubular heating element comprising the steps of disposing a resistance member surrounded by magnesium hydroxide within a metal tube or enclosing sheath, partially converting said magnesium hydroxide to magnesium oxide, initially deforming said sheath to partially compact the hydroxide and oxide, completing the conversion to magnesium oxide, and further deforming said sheath to additionally compact the oxide.

8. The method of making electric heating elements comprising the insertion of a magnesium metal lining into a metal sheath, placing a resistance member inside the magnesium lining, treating the assembled unit with steam or water under high pressure and temperature to convert the magnesium metal into magnesium hydroxide, partially dehydrating the hydroxide, reducing the cross-sectional area of the sheath to compact the hydroxide material within the sheath, completing the dehydration of the material, and further reducing the cross-sectional area of the sheath to compact the material.

CHRISTIAN B. BACKER.

EXHIBIT J.

216 Div. 60 Room 301 Paper No. 16
Mailed Mar 20 1943

Department of Commerce
United States Patent Office

Before the Board of Appeals

In re application: Edwin L. Wiegand, Serial No. 361997, Filed Oct. 21, 1940
For: Electrical Heating Elements

Examiner's Statement

This is an appeal from the final rejection of claims 12, 14-22 and 33-46. These claims constitute all the claims now in the case with the exception of claim 13, which has been set aside under the provisions ofRule 41 as reading upon the non-elected species illustrated in Fig. 16 pending determination of the allowance of any generic claim.

The claims read as follows:

Claim 12: An electrical heating element, comprising: a metal sheath, having a generally triangular cross-sectional outline; resistor means disposed within and insulated from said sheath, said resistor means being substantially continuously distributed approximately in a plane longitudinally of one side only of said sheath.

Claim 14: The process of making on electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a cross-sectional outline comprising a plurality of substantially straight line portions, two of which portions respectively make interior angles of less than ninety degrees relatively to another of said portions.

Claim 15: The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

217 Claim 16: The process of making an electrical heating element, which comprises: providing a metal sheath, of circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath to a generally triangular cross-sectional outline.

Claim 17: The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different from said oblong outline.

Claim 18: The process of making an electrical heating element, which comprises: providing a metal sheath, of circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline.

Claim 19: The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal axis of which is rectilinear and the cross-sectional outline of which is circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a cross-sectional outline different from said oblong outline.

Claim 20: The process of making an electrical heating element, which comprises: providing a metal sheath the longitudinal axis of which is rectilinear and the cross-sectional outline of which is substantially circular, said sheath having a resistor embedded in refractory electrical insulating material disposed therein and insulating said resistor from said sheath; applying pressure to said
218 sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; bending said portion in the minor axial general plane of said portion so that the longitudinal axis of said portion is non-rectilinear; and applying pressure to said bent portion to deform at least a part thereof to a generally triangular cross-sectional outline.

Claim 21: The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than the perimeter of the original cross-sectional outline of said portion.

Claim 22: The process of making an electrical heating element, which comprises: providing a metal sheath having a resistor embedded in refractory electrical insulating material disposed within said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generallyV-shaped cross-section; applying a second die to said sheath and moving said second die toward said first die until said sheath is deformed to a generally triangular cross-sectional outline and the pressure applied by said second die to the part of the surface of the sheath in contact therewith is of the order of 25 tons or more per square inch of said surface.

Claim 33: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 34: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions, and said two
portions making between them an angle of substan-
219 tially less than ninety degrees; compacted refractory
heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming

to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 35: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially sixty degrees relatively to another of said portions; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 36: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions, and said two portions making between them an angle of at least ninety degrees; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 37: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 38: An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 39: An electrical heating element, comprising: a metallic sheath having portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral end portion bent so as to extend at an angle to said plane.

Claim 40: An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of said axis; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

Claim 41: An electrical heating element, comprising: a metallic sheath having at least a portion bent so that the longitudinal axis thereof is non-rectilinear and lies substantially in a plane, said bent portion having wall portions defining a closed generally triangular cross-sectional outline, one of said wall portions lying substantially in a plane parallel to the plane of the axis; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material; and said heating element including an integral portion bent so as to extend at an angle to said planes.

221 Claim 42: An electrical heating element, comprising: a metallic sheath; resistor means within and insulated from said sheath, said resistor means being substantially continuously distributed longitudinally of a portion of said sheath, said resistor means defining a surface unsymmetrical with respect to the cross-sectional outline of the inside surface of said sheath so that the sheath portion nearest said resistor means is directly heated to a substantially greater extent than the remainder of said

sheath, said surface defined by said resistor means being circumferentially discontinuous in cross-sectional aspect, extending circumferentially along a part only of the cross-sectional outline of said inside surface.

Claim 43: An electrical heating element, comprising: a metallic sheath; resistor means within and insulated from said sheath, said resistor means being substantially continuously distributed longitudinally of a portion of said sheath, said resistor means defining a surface unsymmetrical with respect to the cross-sectional outline of the inside surface of said sheath so that the sheath portion nearest said resistor means is directly heated to a substantially greater extent than the remainder of said sheath, said surface defined by said resistor means being approximately uniformly spaced from said inside surface longitudinally and circumferentially and extending circumferentially along a part only of the cross-sectional outline of said inside surface.

Claim 44: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of at least one of said wall portions.

Claim 45: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed gen-

erally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said
222 compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of at least one of said wall portions.

Claim 46: An electrical heating element, comprising: a metallic sheath having wall portions defining a closed generally triangular cross-sectional outline; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material, said resistor means being so distributed as to define a surface similar to and extending collaterally with respect to the inside surface of only one of said wall portions.

The following references have been relied on:

Kercher et al	1,835,602	Dec. 8, 1931
Cook	1,174,548	Mar. 7, 1916
Internat'l. G.E. (British)	418,155	Oct. 19, 1934
Backer	2,157,884	May 9, 1939
Vogel	2,094,480	Sept. 28, 1937
Cubitt	1,019,426	Mar. 5, 1912
Ayer et al	905,045	Nov. 24, 1908
Woodson	1,705,696	Mar. 19, 1929

The alleged invention comprises a tubular sheathed embedded electrical heating element having a triangular cross-section wherein the coiled or sinuously formed resistor wire occupies a zone parallel to one or more sides of the triangular section, and is held in place by the embedding refractory insulating material. The elongated heating element is formed into a spiral unit suitable for well-known hot-plate structure. Invention is also urged for the process of making the element, comprising assembly as a straight tube of circular section, then forming by suitable dies into the triangular section and bending into the spiral shape.

223 Kercher et al shows a tubular sheathed electrical heating element whose Fig. 9 shows the sheath to have a triangular section.

Cook illustrates a tubular sheathed embedded electrical heating element wherein the convoluted wire is disposed eccentrically within the sheath so as to direct the radiation of heat in a specific direction. As shown in his Fig. I, the tube is disposed as an annulus.

The British patent discloses a tubular sheathed embedded electric heating element with three ways of directing the radiated heat in a specific direction; by eccentric location of the convoluted wire, by using insulation differing in thermal conductivity, and by a combination of these two methods.

Woodson shows a tubular sheathed embedded electric heating element whose flat casing encloses a resistor which is continuously distributed in a plane parallel to the working face of the element..

Backer discloses a tubular sheathed embedded electric heating element with various shapes of cross-section formed from the circular section by means of dies. His Fig. 4 shows a semi-circular section closely approximating a triangular section. He does not bend the element as do the other references, but makes a hairpin unit with the flat sides together, as shown in Fig. 5.

Vogel illustrates a tubular sheathed embedded electric heating element bent spirally into a unit with end portions bent at an angle to the spiral plane. His Figs. 3 and 4 show flattened top or top and bottom sections, with the wire convolutions conforming to the shape of the sheath.

224 Cubitt illustrates a tubular electric heating element such as his Fig. 4 which when deformed is unsymmetrical as shown in his Fig. 5.

Ayer et al shows a plate-like electric heating element with "V" grooves wherein a sinuously formed resistor such as his Fig. 6 is formed discontinuously into the grooves so as to present greater radiation in a specified direction.

Claims 14-22 have been rejected for misjoinder of invention. These claims constitute the non-elected group from two groups between which a requirement of division was made by the examiner and approved by the Classification Examiner as follows:

"The requirement of division between:

I Article claims 1-13

II Method claims 14-22

is approved.

The article could be made as described by applicant on page 4, the tube be prefabricated or preshaped to the desired cross sectional dimensions.

In the method, which involves the provision of a prefabricated article, the steps of shaping are equally as applicable to any tubular or rod-like structure.

The art of record indicates that class 201, although it provides no separate status for article and process inventions, does have patents wherein novelty in one exclusively of the other has been recognized."

Claims 12 and 46 are believed to be unpatentable over Kercher et al in view of either Cook or the British patent and Woodson. To arrange the resistor in a plane as taught by Woodson, and to dispose it eccentrically so as to direct the radiation of heat in a specific direction as to the British patent and Cook, have been considered as features

225 aggregated with the triangular section of Kercher

et al to form the attempted combination in this claim. The various features thus present in the art do not appear to coact in any new or unobvious way.

Claims 33-37, 44 and 45 are considered unpatentable over Backer. (This reference was filed Jan. 16, 1936.) Backer's Fig. 4 discloses a cross-sectional shape which differs immaterially from the substantially triangular shape of the claims. Backer does not feature the manner of bending the element in any exclusive way, merely mentioning that it "may be conveniently bent into hair-pin form—." It is believed that the casual manner of this statement and the sentence, "There may also be other shapes into which the tube may be formed for special purposes" indicate that Backer certainly did not exclude the contemplation of the spiral bending well known in the art.

Claims 38-41 are deemed unpatentable over Backer in view of Vogel. Vogel discloses a non-rectilinear axis for his unit, and an integral end portion bent at an angle to the plane of the top, and also a flattened portion on his sheath which is parallel to the plane of the axis; it is considered not to require invention to dispose Backer's element in the same manner.

Claims 42 and 43 have been rejected as being unpatentable over Cook or the British patent 418155, each in view of Cubitt or Ayer et al. Both Cubitt and Ayer et al show
resistor means discontinuous circumferentially;
226 while this is regarded as an arbitrary limitation, it
nevertheless is thought not to require invention to so dispose the helical resistors in the elements of Cook or the British patent. The limitation is considered arbitrary since substantially equivalent results are more easily attainable in the manner shown by Cook and the British reference.

For the aforementioned reasons the final rejection of the claims is thought to be proper.

Respectfully submitted,

R. L. Glass,
CEF-jb *Examiner, Div. 60.*

Exhibit K.

227 Filed Mar. 9, 1944

Paper No. 25

Appeal No. 46,329 MSP

Hearing:
February 7, 1944

In the United States Patent Office

Before the Board of Appeals

Ex parte Edwin L. Wiegand

Application for Patent filed October 21, 1940, Serial No. 361,997. Electrical Heating Elements.

Messrs. Freeman, Sweet & Albrecht and Messrs, Freeman, Sweet, Albrecht & Williams for applicant.

The applicant has appealed from the action of the examiner finally rejecting claims 12, 14 to 22, inclusive, and 33 to 46, inclusive.

Claim 33 may be taken as an example.

33. An electrical heating element, comprising: a metallic sheath having wall portions defining a closed cross-sectional outline comprising a plurality of substantially straight line portions, two of said portions respectively making interior angles of substantially less than ninety degrees relatively to another of said portions; compacted refractory heat-conducting electrical-insulating material disposed within said sheath and in heat-transfer contact with the inside surface of said sheath at said wall portions, the cross-sectional outline of said inside surface and the cross-sectional outline of said insulating material conforming to each other; and resistor means embedded in said compacted insulating material and insulated from said sheath by said insulating material.

228 The references relied upon are:

Ayer et al,	905,045,	Nov. 24, 1908,
Cubitt,	1,019,426,	Mar. 5, 1912,
Cook,	1,174,548,	Mar. 7, 1916,
Woodson,	1,705,696,	Mar. 19, 1929,
Kercher et al,	1,835,602,	Dec. 8, 1931,
British Patent,	418,155,	Oct. 19, 1934,
Vogel,	2,094,480,	Sep. 28, 1937,
Backer,	2,157,884,	May 9, 1939.

The disclosure relates to electrical resistance heating units comprising, as shown in Fig. 2 and others, a resistor 31 embedded in refractory electrical insulating heat conducting material and uniformly spaced from the inside wall of the sheath 30. Applicant uses any method of compacting the insulating material which will not elongate the sheath and then side presses the sheath 30 so that it is elliptical or oval or of oblong form in cross-sectional outline. The side pressing serves to compact the insulating material 32 to a sufficient degree to maintain the resistor 31 in a central position when the element is bent or otherwise worked. The specification on page 7 states, in substance, that even if the perimeter of the cross-section shown in Fig. 8 is the same as that of the original, the forging to a triangular cross-section results in a very large reduction in cross-sectional area and in compaction of the insulating material 32 to very great density.

The examiner has rejected claims 12 and 46 as unpatentable over the patent to Kercher et al in view of either Cook or the British patent and Woodson. The examiner holds that to arrange the resistor in a plane as taught by Woodson and to dispose it eccentrically so as to direct the radiation of heat in a specific direction as is done by the British
patent and the Cook patent are considered as features
229 aggregated with the triangular section of Kercher
et al to form the attempted combination in these
claims. The examiner further holds that the various features thus present in the art do not appear to coact in any new or unobvious way.

It is argued that the Kercher et al patent, which the examiner uses as the basic reference, has not solved appellant's problem. It is argued that Kercher et al fail to disclose a combination of claims 12 and 46 and the mode of operation and that the examiner proposes, in view of Fig. 1 of the British patent, not only to provide some means whereby the helical resistor 13 of Kercher et al will be unsymmetrically disposed but then proposes to do away entirely with a helical resistor. It is further stated that the examiner then proposes to take the plane resistor 11 of Woodson out of its environment where it does not function as applicant's resistor 60 functions and reconstruct Kercher et al somehow so that the resistor will be so disposed that it defines a plane longitudinal of one side only of the sheath. Appellant states that to build up the combinations set out in claims 12 and 46, the examiner must reconstruct all of at least three citations and it is contended that a mere statement of the rejection shows it to be untenable.

While the examiner has broadly found the features of these claims in different references and has taken the position that to assemble them into one mechanism involves an aggregation, it appears that the Kercher et al mechanism does not provide a resistor distributed in a plane longitudinal of one side only of said sheath. While the British and Cook patents disclose the broad idea of arrang-
230 ing the resistor nearer one side than the other of the sheath, these two claims do not appear to be limited in that particular. Claim 12, for example, calls for the resistor being in a plane longitudinally of one side only of the sheath and the examiner relies on the Woodson patent to show this relation. It appears, however, that in all the forms of the Woodson patent shown the resistor is in a plane longitudinally of both sides of the sheath because of the shape or form in which Woodson arranges it. Both of these claims are limited to the resistor being in a plane or surface longitudinally of one side only of the wall portions. It is our view that these claims are not aggregative

and that they are patentable over the combination of references applied by the examiner.

Claims 33 to 37, inclusive, 44 and 45 have been rejected on the patent to Backer. The examiner points out that Fig. 4 of Backer discloses a cross-sectional shape which differs immaterially from the substantially triangular shape of the claims. It is argued that the examiner is in error in stating that Backer's Fig. 4 discloses a cross-sectional shape which does not differ materially from the substantially triangular shape of the claims. It is further argued that Backer's Fig. 4 does not show a triangular section and does not show a cross-sectional outline defined by a plurality of straight sides as called for in this group of claims.

We are in agreement with the position of the examiner to the effect that the cross-sectional shape of the Backer device in Fig. 4 does not differ materially from the triangular shape of the claims. It is true that the side
231 portions are not straight line portions but it is considered that they are the equivalent of substantially straight line portions in so far as these claims are concerned. The patent to Vogel, for example, shows that it is old in the art to form electric heating elements into the shape of a spiral and it is considered that it would not amount to patentable improvement to form the heating element of Backer of the specific type shown in Fig. 4 into a structure of the general shape of a spiral for use as is the spiral of the Vogel patent.

The examiner has rejected claims 38 to 41, inclusive, on Backer in view of Vogel and it is considered that this rejection is proper.

Claims 42 and 43 have been rejected as unpatentable over Cook or the British patent in view of the patents to Cubitt and Ayer et al. The examiner states that Cubitt and Ayer et al show resistor means discontinuous circumferentially and it is thought by him not to require invention to so dispose the helical resistors in the elements of Cook or the British patent.

Appellant points out that the British and Cook patents show the surface defined by the resistor as being cylindrical and therefore not circumferentially discontinuous. It is argued that making the cylindrical surface defined by the resistor means small with respect to the outline of the sheath and displacing that cylindrical surface so that it is nearer one part of the sheath wall than the opposite part results in the part of the cylindrical surface of the resistor
means being in poor heat-conducting relation to the
232 upper part of the sheath wall. Appellant further
states that by making the resistor means so that it defines a surface which is circumferentially discontinuous as set forth in claims 42 and 43, the objections stated are eliminated.

It is considered that these claims are patentable over the references and reasons given by the examiner.

The examiner has rejected the method claims as being directed to a non-elected group and points out that division was required by the examiner between the method claims and the article claims. It appears, as stated by the Classification Examiner, that the article can be made by other methods than that set out in these claims and it is considered that the requirement for division is proper.

For the reasons indicated, the decision of the examiner is reversed as to claims 12, 42, 43 and 46, but is affirmed as to the other appealed claims.

W. L. Redrow,
Examiner-in-Chief,
E. T. Morgan,
Examiner-in-Chief,
V. I. Richard,
Examiner-in-Chief,
Board of Appeals.

March 9, 1944

Messrs. Freeman, Sweet, Albrecht & Williams,
Hanna Bldg.,
Cleveland, Ohio.

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EXHIBIT M.

235 Filed Oct 13 1943

Div. 60—Room 301 Paper No. 13

CEF/lcm

Department of Commerce
U. S. Patent Office
Richmond, Virginia

In re application of

Edwin L. Wiegand

Serial No. 390,371

Filed: April 25, 1941

For: Electrical Heating Elements

Before the Board of Appeals on Appeal

Examiner's Statement

This is an appeal from the final rejection of claims 2-5, 10, 12, 18 and 20. Claims 6, 7, 13, 16, 17 and 19 stand allowed. The finally rejected claims are as follows:

Claim 2. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

Claim 3. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath to a generally triangular cross-sectional outline.

236 Claim 4. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

Claim 5. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a generally triangular cross-sectional outline.

Claim 10. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline the perimeter of which is less than the perimeter of the original cross-sectional outline of said portion while the length of said portion is unaltered.

Claim 12. The process of making an electrical heating element, which comprises: providing a metal sheath having a circumferentially continuous wall having a resistor embedded in refractory electrical insulating 237
material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying to said sheath-portion a second die having a surface cooperable with said matrix to deform said sheath-portion to a generally triangular cross-sectional outline, and moving said dies toward each other until said sheath-portion is deformed to a generally triangular cross-sectional outline and the pressure between said second die and the part of the surface of the sheath-portion in contact therewith is of the order of 25 tons or more per square inch of said surface.

Claim 18. The process of making an electrical heating element, which comprises: providing a metal sheath, having a circumferentially continuous wall of substantially circular cross-sectional outline, and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to an oblong cross-sectional outline the major axis of which is substantially equal in length to the diameter of said circular cross-sectional outline; and applying pressure to said so deformed portion to deform at least a part thereof to a cross-sectional outline different in shape from said oblong outline.

Claim 20. The process of making an electrical heating element, which comprises; providing a metal sheath having a circumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; disposing at least an active portion of said sheath in the matrix of a first die, said matrix being of generally V-shaped cross-section; applying to said sheath portion a second die having a surface cooperable with said matrix to deform said sheath-portion to a generally triangular cross-sectional out-
238 line, the cross-sectional perimeter of the cavity left
when said dies are brought together being such that when said dies are brought together the cross-sectional perimeter of said generally triangular cross-sectional outline is less than the perimeter of the original cross-sectional outline of said sheath; and moving said dies toward each other until said sheath-portion is deformed to said generally triangular cross-sectional outline.

The following reference has been relied upon:

Backer	2,157,884	May 9, 1939

The invention comprises the process of making an electrical heating element of the metal incased resistance coil variety wherein the insulation around and through the coil is an embedding powdered refractory. The process involves deforming an originally circular seamless tube filled with powdered insulation embedding a coil of also circular section. The deforming is accomplished in either one step, directly to a triangular section; or in two steps wherein the first step deforms to an "oblong," that is, elliptical, section; or in three steps, wherein an intermediate step of bending of the longitudinal axis takes place. Where this intermediate bending is used, the die making the last step of final deformation must have the special axial shape as well as cross-sectional characteristic desired. When the ellipti-

cal deformation is performed, the resulting major axis is kept equal to the original circular diameter, so that the deformation is restricted to that along the minor axis. As is usual in forming operations of this kind, the finished
239 cross-sectional area is less than the original, whereby
a compacting of the refractory is effected. This incidentally reduces the perimeter of the tube, also. Where the triangular section is evolved through an intermediate elliptical section, the altitude of the triangle is made along the major axis of the ellipse, which is a natural orientation to make in order to effect symmetrical deformation.

The reference, *Backer,* discloses a process of making an electrical heating element of the metal incased resistance coil variety with magnesium oxide insulation. Deformation by pressing in dies is illustrated, and Fig. 4 shows a shape, approximately semi-circular, which section is particularly pertinent to this case. Furthermore, on his page 2, column 2, lines 13-32, he describes a method by which the final shape is effected by ‘‘a second deforming operation.’’ Backer’s tube is seamless, and starts out circular in form. As is obvious from the figures, the resistance coil shape corresponds to the sheath shape throughout the deformation process. On his page 2, column 2, lines 44—67, he describes inherent reduction of circumference (perimeter) and non-lengthening of the tube as a result of cross-sectional deformation.

Claims 2-5, 10, 12, 18 and 20 are submitted to be unpatentable over Backer. Where the claims recite deformation to a ‘‘generally triangular’’ cross-section, Backer’s Fig.
240 4 showing a semi-circular section is considered sub-
stantially anticipating. If there is any advantage in a generally triangular’’ conformation over a semi-circular one, it does not appear in these claims nor in the description pertinent to these claims. Backer in his Fig. 5 shows one adaptation of his Fig. 4 shape, but does not necessarily limit the shape to that use. What Backer does in the way of bending of the axis of the tube, as well as what

applicant does in this regard, is moot in these claims. Some claims including this bending operation have been allowed.

The limitation, as in claim 12, to a particular forming pressure, where such pressure is neither critical nor unusual to this kind of process, is considered an obvious step which lacks novelty.

The limitation to deformation by stages is likewise anticipated by Backer on his page 2, column 2, lines 70-72.

It is submitted that these claims have been properly finally rejected.

Respectfully submitted,

R. L. Glass,

CEF *Examiner*—Division 60.

Exhibit N.

241 Filed Mar 9, 1944

Paper No. 16

Appeal No. 48,835 MSP

Hearing:
February 8, 1944

In the United States Patent Office

Before the Board of Appeals

Ex parte Edwin L. Wiegand

Application for Patent filed April 25, 1941, Serial No. 390,371. Electrical Heating Elements.

Messrs. Freeman, Sweet & Albrecht and Messrs, Freeman, Sweet, Albrecht & Williams for applicant.

This is an appeal from the action of the examiner finally rejecting claims 2 to 5, inclusive, 10, 12, 18 and 20.

Claim 2 is illustrative and reads as follows:

2. The process of making an electrical heating element which comprises: providing a metal sheath having a cir-

cumferentially continuous wall and having a resistor embedded in refractory electrical insulating material disposed within and having a cross-sectional area corresponding to that of the inside of said sheath and insulating said resistor from said sheath; and applying pressure to said sheath so as to deform at least an active portion of said sheath from its original cross-sectional outline to a generally triangular cross-sectional outline.

The reference relied upon is:

Backer, 2,157,884, May 9, 1939.

242 Claims 2 and 3 differ from Backer in that the final cross-section of the sheath is triangular. Backer was not limited to any particular shape (page 2, line 11, right) and it would be a mere matter of choice to select the triangular die necessary in the process as claimed. Furthermore, Backer states that the deforming may be carried out in several steps. It would also be a matter of degree to modify the shape of Backer's Fig. 4 by flattening opposite sides of the circular perimeter portion shown in Fig. 4.

Applicant contends that the triangular element is of extreme rigidity and provides an optimum combination of rigidity and strength with a greater ratio of sheath area to element, volume and weight. These are article details which do not necessarily make the process patentable.

Backer describes the two pressing steps at lines 30 to 40, column 1, page 2 and lines 20 to 30, column 2, page 2 and states that the same or similar dies are used. We believe it obvious that dies slightly different from the dies used in the first deforming step could be used in the Backer process and the broad idea of using dies progressively changing shape until the final shape is reached is obvious.

Furthermore, the processes of claims 4 and 18 do not require that the final shape be triangular and while claim 5 does require this final form, we believe it to be only a matter of choice and obvious as a process step especially where the final article does not appear to have any advan-

tages over Backer's article. Applicant's degree of compression on the insulating refractory may be greater than that attained by Backer but this is a difference in
243 degree only.

Claim 18 has another limitation as to the shape attained in the first pressing step. This is said to maintain the resistor in symetrical position within the sheath. Backer does not disclose this feature.

The decision of the examiner is reversed as to claim 18, but is affirmed as to the other appealed claims.

C. H. Shaffer,
Examiner-in-Chief,

F. J. Porter,
Examiner-in-Chief,
V. I. Richard,
Examiner-in-Chief,
Board of Appeals.

March 9, 1944

Messrs. Freeman, Sweet, Albrecht & Williams,
Hanna Bldg.,
Cleveland, Ohio.

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REPLY BRIEF OF APPELLANT

In The

United States Court of Appeals

For the District of Columbia

NO. 9135

EDWIN L. WIEGAND COMPANY,
Appellant,
v.
CASPER W. OOMS,
Commissioner of Patents,
Appellee.

United States Court of Appeals
for the District of Columbia
FILED NOV 15 1946
Joseph W. Stewart
CLERK

Appeal from a Judgment of the District Court of the United States for the District of Columbia.

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IN THE

United States Court of Appeals

FOR THE DISTRICT OF COLUMBIA

NO. 9135

EDWIN L. WIEGAND COMPANY,
Appellant,

v.

CASPER W. OOMS,
Commissioner of Patents,
Appellee.

APPEAL FROM A JUDGMENT OF THE DISTRICT COURT OF THE UNITED STATES FOR THE DISTRICT OF COLUMBIA.

REPLY BRIEF OF APPELLANT

STATEMENT

The Brief for Appellee argues for refusal of the claims on appeal, that applicant has not carried his date of invention back of the effective dates of the Vogel and Backer patents, and on that premise, that the claims on appeal do not define invention over the Vogel and Backer patents. (Brief for Appellee, the section entitled "Summary of Argument", appearing at page 3.)

In this situation, obviously it is incumbent that appellee prevail on both points, otherwise the basis of refusal is not sustained.

That the claims on appeal do ~~not~~ define invention, even assuming the Vogel and Backer patents to be available against the claims in suit, has been presented in the Brief of Appellant, to the extent of the ability of counsel, particularly in the section entitled "Invention", appearing at pages 17-20, and the Brief for Appellee contains nothing new, and therefore this brief is directed solely to the point that the Vogel and Backer patents are not available in any event against the claims on appeal.

THE PRESENT ISSUE

The Brief of Appellant shows, generally in the section entitled "Statement of the Case", appearing at pages 2-11, and specifically in the section entitled "Priority", appearing at pages 20-22, that prior to the effective date of either the Vogel patent or the Backer patent, applicant had constructed and tested:

(A) The elliptical element Exhibit 3 (physical), illustrated in the drawing Exhibit 4 (R. 95), and obviously substantially identical in cross-section with the elliptical element of Figure 2 of the Backer patent (R. 106).

(B) Elements precisely as shown in the Vogel patent (R. 101), and including pressed on one side, Figure 4, or pressed on both sides, Figure 3.

(C) Semi-cylindrical elements, illustrated by the drawing Exhibit 5 (R. 97), and including straight, as in Figure 4 of the Backer patent (R. 106), and also bent into abutment, as shown in Figure 5 of the patent.

Thus prior to the effective date of either of the reference patents, applicant had constructed and tested everything shown in either of the reference patents, except only the strip and diamond cross-sections shown respectively in Figures 1 and 3 of the Backer patent (R. 106), and neither of these has ever been relied on by appellee, or is capable of being relied on, plainly for the reason that either is entirely inferior, for example, to the semi-cylindrical form of Figure 4 (R. 106).

In fact the entire reliance is on the semi-cylindrical form of Figure 4 of the Backer patent (R. 106), in conjunction with the spiraling of the Vogel patent (R. 101).

Substantially the foregoing is at least tacitly admitted and agreed.

The entire argument of appellee in respect of availability of the Vogel and Backer patents, is contained in the section of the Brief for Appellee, entitled "Argument", appearing at pages 3-5, and presents only the following:

(a) By the first sentence of the section, page 3, a general reflection on appellant's position.

(b) By the remainder of the first paragraph of the section, also page 3, an argument premised on the proceeding in the Court below.

(c) By the remainder of the section, pages 3-5, an argument that applicant is not entitled to the benefit of his earlier acts, on the premise that they did not constitute reductions to practice, and that appellant has not shown due and proper diligence by which applicant nevertheless would be so entitled, even if the acts were not reductions to practice.

These then are the matters for consideration in this brief in reply.

REDUCTION TO PRACTICE

In regard to the matter of reduction to practice, one part of item (c), at the bottom of page 3 appellee notes that the applications on which the Vogel and Backer patents were granted, were filed respectively May 16, 1936, and January 16, 1936, from which appellee presumes that these are the effective dates of the respective patents.

At the upper part of page 4 appellee states that "If the appellant is to establish that he is the first inventor of anything shown by these patents, he must show either that he had reduced the thing relied on to practice prior to the filing dates of the applications on which the patents were granted, or that he conceived it prior to such date and coupled his conception, by diligence, with a subsequent reduction to practice."

However, then appellee proposes, also page 4 of the Brief for Appellee:

"In order to establish reduction to practice, a successful test must be proved", and thereupon appellee argues, pages 4 and 5, that what applicant did, did not constitute successful test, on the basis that the elements were not considered suitable, and were not adopted for production and sale.

In support of the proposal appellee cites *Paul v. Dunn,* 34 App. D. C. 132, and *Liebmann et al. v. Newcomb,* 50 App. D. C. 185, 269 F. 701.

Appellee presents no quotation from either decision, thus to show that either decision does support appellee's proposal, and in fact neither decision is any support for the proposal.

In the Liebmann case, the issue was a tungsten contact secured to a ferrous plate. Newcomb tendered a structure wherein the original tungsten contact had entered into an alloy with the ferrous plate, and therefore no longer existed. And the decision was merely that this did not respond to the issue.

On the other hand, the decision in the Paul case is pertinent to appellee's proposal, but not only does not support the proposal, but states the significantly different definition, as follows (at 134):

> "in order that a device may be a reduction to practice, it is necessary in every case, except that of a very simple device, that it be tested."

However, there is no denial that applicant's prior devices were tested, and therefore appellee's one pertinent decision obviously denies appellee's proposal, and supports appellant.

Further, it seems well established that it is quite unnecessary to reduction to practice, that the device ever be put into commercial manufacture or sale.

For example, it was said here, as far back as 1841, by Judge Cranch, "I do not consider the expression 'reduced to practice' as importing the bringing of the invention into use." (*Heath v. Hildreth,* Fed. Cas. 6309, 11 Fed. Cas. 1003, at 1006.)

So also it was said by Mr. Justice Taft, in *Corona Cord Tire Company v. Dovan Chemical Corporation,* 276 U. S. 358, at 384:

> "It is a mistake to assume that reduction to use must necessarily be a commercial use. If Kratz discovered and completed, as we are convinced that he did, the first use of D. P. G. as an accelerator in making vulcanized rubber, he does not lose his right * * * because

he does not subsequently sell the rubber thus vulcanized, or use his discovery in trade, or does not apply for a patent on it. It is not an abandoned experiment * * *."

However, it was essential to appellee's proposed basis for refusal of the claims on appeal, that applicant's earlier devices should have been merely abandoned experiments, and not reductions to practice, and thus one essential link in the proposed basis of refusal is missing entirely.

DILIGENCE

In the above situation, presumably it is immaterial that applicant exhibited diligence, and certainly the matter should not be labored at length.

However, while appellant concluded that there was no suitable construction (Calhoun, R. 21; Cunningham, R. 29), nevertheless applicant persisted, and in due course achieved the solution, in any event by October 25, 1937 (Calhoun, R. 22; Cunningham, R. 30).

Considering that this was a matter essentially of inspiration, with no possibility of doing anything further until the inspiration occurred, it seems that the very fact of the subsequent solution, in itself demonstrates that applicant continued to have the matter in mind, seeking to capture the inspiration, and thus doing everything that he possibly could do.

Wherefore it is submitted, even if the earlier constructions had not been reductions to practice, applicant did exhibit due and proper diligence, and nevertheless is entitled to the benefit of the earlier constructions, and also for this reason the essential link in the proposed basis for refusal of the claims on appeal again is entirely missing.

PRIORITY

Reverting to item (a) above, the Brief for Appellee contains at page 3:

"The appellant appears to argue that, in some way, certain early experiments of his antedate the reference patents."

It is difficult to conceive that there is any uncertainty in this respect, particularly in view of the remainder of the same section of the Brief for Appellee, but in any event:

Neither of the reference patents is any bar by reason of having issued either two years or one year prior to the applications on appeal, and therefore the proposed basis for refusal of the claims on appeal is simply the premise that the invention, or some part thereof, was "known or used" before applicant's "invention or discovery thereof". (R.S. 4886, U.S. Code, Title 35, section 31.)

However, at least everything of the reference patents in any way pertinent to the claims on appeal, in fact was first invented by applicant, prior to the earliest date available to either of the reference patents.

Thus the reference patents are not available to show any invention adverse to applicant, thus nothing of the claims on appeal was "known or used" before applicant's "invention or discovery thereof", and thus the proposed basis for refusal of the claims on appeal fails completely, for this reason alone.

In this situation obviously it is immaterial that the claims on appeal define invention over the reference patents, and there remains only the matter of item (b) above.

IN THE DISTRICT COURT

Referring to the matter of non-availability of the reference patents, the Brief for Appellee contains at page 3:

> "This point was not seriously urged in the lower Court and that Court made no express finding on it and was not requested to make one. However, it is inherent in the Court's holding that the appealed claims are unpatentable over the references, that the Court was of the opinion that the appellant had failed to carry his date of invention back of the effective dates of the references."

The entire facts concerning the occurrences in The District Court are set forth in the Brief of Appellant, in the section entitled "Priority", appearing at pages 20-22, and are at least tacitly admitted, and without repetition fully answer the above contents of the Brief for Appellee.

CONCLUSION

Appellant submits, the judgment of the District Court should be reversed, and either the claims on appeal should be found allowable, or the cause should be remanded to the District Court for a new trial, whichever course may to this Court appear meet and proper.

Respectfully,

Hadley F. Freeman,
Nelson J. Jewett,
Counsel for Appellant.